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* Inscribed Stone at Lewannick :—

The Editors wish to state that the reading of this stone is in dispute. Mr. Langdon (the discoverer of the Inscriptions) gives, in his illustrated account, the Roman letters as INCENVI MEMORIA ;—but the Rev. W. Iago, on the contrary, finds that the 3rd letter is G, the legend being therefore INGENVI MEMORIA, and consequently commemorative of "Ingenuus ;"—(*not* of "*Cenuus*," as the writer of the paper seems to suppose).

Mr. Iago's view has been arrived at, after careful and repeated inspections of the stone, by Mr. Langdon's invitation, and is supported by casts, rubbings, and photographs. The occurrence of G in the Ogham (duplicate) version of the legend, is also evidence in favour of Mr. Iago's identification of the true name of the deceased.

† Pelagic Life : page 325, line 18, for *quadruped*, read *mammal*.

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* Concerning this Inscription, see also p. iv.

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Royal Institution of Cornwall.

SPRING MEETING.

The Spring Meeting was held on May 28th, 1891, at the Rooms of the Institution.

The Chair was taken by the President, Mr. E. Dunkin, F.R.S., who delivered an Address on Mathematical Astronomy. On the motion of Mr. Tweedy, seconded by Sub-Dean Bourke, a vote of thanks to the President, for his address, was carried by acclamation.

The following papers were then read:—

"Private Trade on the Falmouth Packets."—Mr. A. H. Norway.

"Electric Fishes."—Mr. E. Rundle, F.R.C.S.I.

"Thirteen Cornish Landowners. Temp. Henry III."—Mr. W. Sincock.

"Origin and Development of Ore deposits."—Mr. J. H. Collins, F.G.S.

"Note on a Sand-pit on the north east side of Pendennis Head,"—by the late Mr. N. Whitley, F.R.Met.S. This paper was supplemented by a few remarks from Mr. Howard Fox, F.G.S., who said it was the result of probably the last of the late Mr. Whitley's geological excursions.

On the motion of Canon Moore, seconded by Mr. Michell, a hearty vote of thanks was passed to the Authors of papers, and to the Donors to the Museum and Library.

ADDRESS BY THE PRESIDENT.

EDWIN DUNKIN, F.R.S.,
Past-President of the Royal Astronomical Society.

On the last occasion when I had the pleasure of addressing you, I selected for our consideration a few of the more important researches in the physics of astronomy, a subject which has been cultivated with remarkable success during the last thirty years or more. At the same time I was able to draw your attention to some of the marvellous deductions derived from the spectroscopic analysis of solar and stellar light. I also pointed out that for this great work we are chiefly indebted to the energy and perseverance of a few devoted men of science, whose original and refined investigations in astronomical physics have assisted to build up the well-considered theories, on which all our present knowledge of the physical composition and distribution of the heavenly bodies is based. We also considered some of the wonderful astronomical discoveries made from the photographic delineation of the starry heavens by means of the telescopic camera, and I was able to give you some slight idea of the illimitable extent of the universe. Although there is no more interesting section of astronomical research than that represented by what is frequently referred to as the "new astronomy;" it is not my intention to continue the subjects of spectrum analysis and stellar photography, as, on the present occasion, I am anxious to offer a few remarks on some of the principal advances made in the "old astronomy," especially in relation to the physical features and movements of the different members of the solar system. Before, however, entering on the consideration of these important subjects, it is only proper that I should refer briefly to some matters illustrating the progress of the Institution during the past year, for some of the details of which I am again indebted to the kindness of my friend, our excellent Honorary Secretary.

At our Spring Meetings the first duty of the President is usually a melancholy one, as his thoughts are naturally directed to the memory of those who until recently were included among

our members, but now surviving only in their works. I regret to notice that the names of several members of long standing have disappeared, by death, from the roll of the Institution, most of whom have been much interested in its proceedings, and in scientific pursuits generally. Many of these losses by death during the past year have been already recorded by the Council in their last Annual Report. It is appropriate, however, to repeat their names here, and to add a few personal remarks to what has been there given.

By the death of Mr. Nicholas Whitley, C.E., a Member of of the Council, and a former Honorary Secretary and Vice-President, the Institution has lost one of its oldest supporters, who always took a deep and intelligent interest in its affairs. He was officially connected with the management of the Institution for the long period of thirty-two yeass, and from 1859 to 1879 discharged the duties of Honorary Secretary with great efficiency. Though much occupied with the details of his profession, Mr. Whitley found time to prepare many interesting and valuable papers on geological, archæological, meteorological, and agricultural subjects, the first being a contribution in 1840 to the Reports of this Institution. The titles of about fifty papers are given in the "Bibliotheca Cornubiensis." Latterly, he turned his attention to the critical study of the probable origin of the flint implements discovered in the Brixham Cavern and other places, in relation to their evidence of the antiquity of man. He was also much interested in the enquiry on the influence of climate on agriculture, as shown by the sensible remarks contained in his papers published in the Journal of the Royal Agricultural and other Societies. By the death of Mr. Whitley, local science generally has been deprived of a most devoted supporter. Though he had arrived at a good old age, he was a regular attendant at the meetings of this Institution, at which his well-known face will be sadly missed during many years to come. Mr. Whitley was a Fellow of the Royal Meteorological Society.

Geological and mineralogical science has lost one of its highest authorities by the death of Sir Warington W. Smyth, F.R.S., a Vice-President of the Institution, who suddenly and peacefully passed away in his study on June 19, 1890, in the

full plenitude of his powers. In early life, through the influence of Sir Henry De la Beche, he was attached to the Geological Survey as Mining Geologist, and in this capacity was the author of some valuable memoirs, especially on certain mining districts in Wales and Ireland. In 1851, when the School of Mines was established in Jermyn Street, he was appointed lecturer on mining and mineralogy; and the Professorship of mining in the Royal College of Science, South Kensington, he retained to the day of his death. Sir Warington Smyth held for a long period the important office of Inspector of the mineral property of the Duchy of Cornwall, and also that of Chief Mineral Inspector to the Crown, through which he became intimately connected with the mining interest in Cornwall. During a portion of each year, he usually resided at Marazion, where he was much respected, both in that town and at Penzance; so much so that he was one of the four gentlemen selected by the Town Council of Penzance as the first to have their names inscribed on the roll of Freemen of that borough. He was for more than thirty years a member of the council of the Geological Society of London, having filled successively the offices of Secretary, President, and Foreign Secretary. He also had a seat on the council of the Royal Society on several occasions, and was President of the Royal Geological Society of Cornwall. He had an intimate acquaintance with the geology and mineralogy of the western counties, in which he took much interest, as shown in his papers on Cornish mining. He also rendered valuable services to the mining community in connection with various International Exhibitions, especially those of 1851 and 1862; but his most important labours extraneous to his ordinary official work, were performed between 1879 and 1886 as Chairman of the Royal Commission on Accidents in Mines, and it is generally understood that he was the principal author of the report. By the death of this distinguished mineralogist, the nation has been deprived of one of its most active workers in science, and it will be difficult to replace him in the particular branches which he had made especially his own.

Local science has sustained a severe loss by the death of Mr. Thomas Cornish, of Penzance, a gentleman of considerable attainments in natural history, and a contributor to our Journal.

He was a most active public officer, and at the time of his death held numerous appointments in Penzance and neighbourhood. He was formerly President of the Penzance Natural History and Antiquarian Society, and afterwards a Vice-President, and his genial presence at the meetings always afforded pleasure to the members. His death has been much regretted, and by it a great loss has fallen upon the societies of West Cornwall.

Of the many other members of the Institution who have passed away during the past year, it is only proper that I should refer briefly to the great loss the Institution has sustained by the deaths of so many old and long tried members, such as the Rev. Canon Philpotts, of Porthgwidden, a former Vice-President, who will be remembered for the active interest he took in the building of Truro Cathedral, and also for his personal interest in the welfare and prosperity of our Institution; the Rev. G. L. Church, a frequent attendant at our meetings and excursions; Mr. W. J. Rawlings, of Hayle, who assisted the Institution in many ways, particularly at the time when the Mining School was carried on at Truro; and Col. C. D. Fortescue, of Boconnoc, late of the Coldstream Guards, who after the hardships and fatigues endured during the late Egyptian campaign, retired from the service, and passed the greater part of his time on his Cornish estate, where he was much esteemed as a good landlord and a kind friend. The family of Boconnoc have been liberal benefactors to the Institution for more than half a century.

Another loss to the Institution has been caused by the recent death of the Right Hon. Sir Montague E. Smith, who joined us as a subscribing member so long ago as 1849, on his first visit to Truro as a candidate for parliamentary honours. Sir Montague was the brother of our late member, Sir Philip Protheroe Smith, and was thus identified with the interests of this city to the time of his death. He represented Truro in the House of Commons from 1859 to 1865, which he vacated on his elevation to the Bench. Sir Montague was distinguished as a Judge, first of the Court of Common Pleas, and afterwards of the Judicial Committee of the Privy Council. I also regret the death of Mr. George Williams, of Scorrier, who had only recently joined the Institution. I have been informed that had he been spared, it was expected that he would have taken a

considerable personal interest in its work. The recent death of Mr. Edward Trewbody Carlyon has removed a prominent member of a family so well-known in Cornwall, which has been associated with the Royal Institution from its foundation in 1818.

In addition to the above, the late curator, Mr. William Newcombe, has also passed away at the ripe age of eighty-five. He faithfully carried out the wishes of the Council during the long period of thirty-five years, as the curator in personal charge of the Library and Museum. I have had, on several occasions, personal proofs of his kindness and civility, and I am sure that, on his retirement in 1888, he had earned the highest esteem and sympathies of those with whom he had so long been connected. Adopting the expression of the Council in their Annual Report, I may confidently repeat that "to trace the incidents which have occurred during his term of office, would be to give an epitome of the progress of the Institution, he and it having had, as it were, one existence for the third part of a century."

It is very gratifying to be able again this year to speak of the continued progress of the Royal Institution. The public has shown no decrease of interest in the Museum, and the many valued additions, both to it and the library made since I last addressed you, show that our friends in almost every part of the world are still ready to help us. Our member, Mr. Robert Harvey, has again liberally assisted in carrying out the objects of the Institution. Besides a donation of ten guineas, he has presented a rare portrait of the celebrated Henry Rogers, the Helston Pewterer. Mr. Richard Pearce, of Denver, U.S., has presented a further donation of five guineas, and also a collection of British butterflies and bird's eggs, a most valuable addition which will materially assist in completing the collections of objects of this kind already in the Museum. Mr. Walter H. Harris, late Sheriff of London, is the donor of a beautiful set of models of diamonds, gems, and crystallographic forms of minerals, which have been placed in the handsome case presented by him in the spring of last year.

The Museum has also been enriched by a considerable number of valuable contributions from various other friends of the Institution. I have only time to refer to a few of these

presents, but they will be described in full detail in the next Annual Report of the Council. Mr. John D. Enys has, through his influence with Sir James Hector, F.R.S., the Director of the Colonial Museum, New Zealand, procured for us a most valuable collection of books dealing with the natural history and geology of that interesting colony. Mr. James Osborne has sent us a series of mineralogical specimens, illustrating the occurrence of ores in the mines of Spain and Portugal. Mr. J. H. Collins has contributed a small collection of minerals from the mines of Mexico. Mr. E. Rundle, a member of Council, has generously given two cases of Indian butterflies. Interesting specimens of minerals have been presented by Captain Pinwill, Mr. S. Pascoe, Mr. A. H. Carlyon, Captain Bryant, and Mr. Howard Fox, a member of Council; while specimens in other sections of natural history have been contributed by the Rev. W. A. Hamilton, Mr. A. J. Edwards, Mr. W. Harris, Mr. Brown, Mr. T. Clark, and others. Mr. Thurstan C. Peter has presented to the library a copy of "Thesaurus Ecclesiasticus," or a survey of the diocese of Exeter, which is now a rare book. The United States Government has also been very liberal in its gifts of those valued contributions which are submitted to it by the superintending officers of its Geological and Geographical Surveys.

The members will be pleased to know that the series of portraits of gentlemen who have filled the office of President of the Royal Institution of Cornwall, some of which have been wanting, will shortly be completed. In addition to these, several portraits of members who are taking an active interest in the progress of the Institution, have also been presented.

The Curator, Mr. Henry Crowther, has continued the good work referred to in my address this time last year, evidences of which may be found in all parts of the Museum; the re-arrangement of the minerals is still occupying his attention, and it is hoped that, during the present summer, the Cornish section will be completed. Much of the Curator's attention will be directed to the classification of the Indian and British butterflies which the Institution has recently acquired. This classified arrangement will be another step towards bringing the zoological collections together.

During the winter, classes have been established by Mr. Crowther, which have been carried on most successfully in the rooms of the Institution, with the approval of the Council. The subjects taken were botany, geology, mineralogy, and hygiene. The Council would be willing to give their countenance to a further development in this direction.

Parts 36 and 37, forming Vol. X, of the Journal, have both been issued since the last spring meeting. I must congratulate the members on the publication of this important volume. The subject matter contained in it may favourably be compared with that in former volumes, or in the "Proceedings" of most of the London Societies. This general excellence of the papers may be partly due to the effect of the late award of the Henwood Gold Medal, and partly to a growing interest in science, and in the progress of the Institution. Perhaps without the prospect of an early award, we might not have had some of those important memoirs which have assisted in giving a high character to the volume; but there are many other contributions, not included in the terms of the award, which are also of great local interest. Without entering into any detailed analysis of the separate papers—for I have no doubt you have already done this for yourselves—I cannot refrain from making a special reference to the memoirs of Mr. A. G. Langdon and the Rev. W. Iago, and more briefly to one or two others. It gives me much pleasure in stating, and I do so without any hesitation, that, in my opinion, Mr. Langdon's memoir on "The Ornament on the Early Crosses of Cornwall," is a most valuable contribution to Cornish archæology, not only for its originality, but also for the careful classification of the various patterns inscribed on crosses distributed over the county. The subject as treated by Mr. Langdon possesses a charm which makes the paper exceedingly readable and attractive; while it is clear that its preparation must have cost the author much original research and personal application. The memoir on "Some Recent Archæological Discoveries in Cornwall," by the Rev. W. Iago, is also one of high merit, showing, as we might expect, the author's acquaintance with Cornish archæology, which probably can hardly be equalled at the present time. It embodies much new and valuable information, and exhibits originality and depth of

research. If we were to obliterate the name of the author from the title, it would not be difficult to discern that this memoir is the work of a matured and accomplished archæologist—one who has an intimate acquaintance with the antiquities he describes, and the historical bearing they have on the early period to which they may be referred.

Among the other papers contained in Vol X., I ought to draw your attention briefly to the elaborate and important mineralogical and geological memoirs by Mr. J. H. Collins and Mr. Thomas Clark; the three papers on Mediæval Cornish History by Mr. W. Sincock; and to many of the interesting notes on Local Topography which have been prepared with considerable care and attention. Mr. W. H. Tregellas's paper on "The Truro Grammar School," illustrated by two excellent sketches of the exterior and interior of the school by Mr. H. Michell Whitley, will interest many of our older members.

Most of the members, I am sure, will cordially join me in congratulating Mr. G. C. Boase on the publication of his "Collectanea Cornubiensia," a comprehensive and valuable contribution to the personal and topographical history of the county. The vast number of facts included in the text have been accumulating in the hands of Mr. Boase during several years, and the primary object of their publication is the preservation for the use of future writers on Cornwall of all this information, most of which might otherwise have been lost and difficult to ascertain. The numerous items given on matters relating to the county may be conceived, when we consider that the index alone consists of 304 columns, with about 14,365 entries. Some of the family pedigrees are worked out with considerable detail, which must have entailed an enormous labour on the author. These are very valuable in many ways, and I have already derived much interesting information concerning many of our old Cornish families I have also consulted the topographical section with great advantage, in which a mass of local facts may be found relating to most of the parishes and towns in Cornwall. Though in a compilation of such magnitude, numerous unavoidable errors and many entries of little importance may naturally be found, yet every true Cornishman must hail the appearance of the "Collectanea Cornubiensia," which, taken

in conjunction with the "Bibliotheca Cornubiensis," may be considered as one of the most important contributions to the literature of Cornwall published in recent years.

It gave me much pleasure that I was able to preside over the special meeting of the Council held on June 16, 1890, at which the award of the first Henwood Gold Medal was made to the Rev. William Iago, B.A., a Past-President of this Institution, for his excellent memoir on "Recent Archæological Discoveries in Cornwall." I much regret, however, that I was unable to be present at the annual meeting in November, at which the formal presentation was made, but it was very gratifying to me that my esteemed friend, Mr. H. M. Jeffery, M.A., F.R.S., occupied the chair on that occasion, and that his graceful and appropriate remarks sufficiently explained the grounds which guided the Council in selecting the memoir of Mr. Iago as the most important paper published in the Journal during the preceding three years.

I have had considerable experience as a member of the Councils of the Royal Society and Royal Astronomical Society, in assisting in the annual awards of various gold medals for scientific work, and I can truly say that, on these occasions, the most careful scrutiny of the claims of the different nominees is always made before the final decision. Though it is often found that the discrimination between the respective merits of important researches is a difficult matter, and sometimes decided only by a numerical majority, yet I have never known the selection of the medallist questioned, either by the minority in the Council, or by the Fellows of the Society, by whom the judgment of the Council is always received with respect. I can assure you that, in the case of the award of the Henwood Gold Medal, a similar careful consideration was given by your Council to the respective merits of each qualified memoir. I concur most cordially with all that Mr. Jeffery has said on the subject, and I may with advantage repeat here his words, that "the most scrupulous care was taken on weighing the comparative excellencies of the authors, who have written with power in the Journal on widely differing subjects during the preceding three years. In order to mature their own judgment in the last resort, the Council had adopted the practice of eminent contemporary societies in

submitting each remarkable paper to two qualified referees, eminent in their several departments of study." In congratulating our first Henwood Gold Medallist, I am certain that we shall still find him taking an unceasing interest in his favourite investigations, and that Cornish archæology will long continue to receive the benefit of his antiquarian talents, which I have no doubt in the future will be the means of giving us much additional information concerning the habits of our forefathers. Meanwhile, a second gold medal will be awarded in 1893, a knowledge of which, it is hoped, will again awaken sufficient interest among authors to contribute a series of papers on the natural history and antiquities of Cornwall, excelling, if possible, the first-class memoirs which competed for the medal in 1890.

It is pleasing to mention here that Dr. C. Le Neve Foster, a former secretary of this Institution, has been appointed to fill the chair of "The Principals of Mining" in the Royal College of Science, South Kensington, so long and ably occupied by our late Vice-President, Sir Warington W. Smyth. I feel sure that the Cornish friends of Dr. Foster and every member of the Institution are gratified to know that the Government has in this manner shown its appreciation of the eminent abilities exhibited by him as one of its Inspectors of metalliferous mines.

In my address at the last spring meeting, I expressed a desire to deviate, in some measure, from the strictly local character of the addresses of most of my predecessors in this chair, and to devote my remarks generally to the science of astronomy, a subject that has been my daily thought during a somewhat long professional career. In adopting this course, I considered that I was only following the custom of most scientific men, such as the Presidents of the British Association, who invariably choose the subject of their discourses from their own special branches of study. I therefore take for granted that, on occasions like the present, it is far more satisfactory, in a formal address, that the speaker should devote his attention, for the most part, to those scientific or literary subjects with which his usual habits have made him familiar, than to attempt a theme with which he is only imperfectly acquainted. In a general as well as in a scientific point of view, the principal interest attached to a Presidential address consists not to much in the multitude

of things brought forward, as in the individuality of the mode by which they are treated. I propose therefore to confine my remarks to-day, in this the second division of my address, to the consideration of a few points connected with the mathematical and observational sections of astronomy, which have attracted considerable attention during recent years.

The value of a scientific or technical education is gradually becoming more and more acknowledged in most of our great public schools, and there are very few of them which have not, at the present time, some department devoted to the special instruction of one or more branches of practical science. Even astronomy, which is not usually considered to be a very practical science, is now attracting considerable attention, and I am glad to be able to state that one, at least, of our public schools has founded an astronomical observatory, furnished with excellent instruments. The Temple observatory at Rugby School, built some years ago as a memorial to the present Bishop of London, a former distinguished head master, has already done good service towards the promotion of astronomy, and several valuable contributions from it have been published in the "Memoirs" of the Royal Astronomical Society, containing catalogues of double stars and other observations made by some of the masters and senior scholars, many of whom have taken a great personal interest in the work. The successful formation of a new astronomical society, under the name of "The British Astronomical Association" also gives encouraging evidence of the growing interest in the science among those who desire some popular acquaintance with the great truths in astronomy. One of its chief objects is the association of amateur observers, especially the possessors of small telescopes, for mutual help in the organisation of the work in different sections of astronomical observations. I have no doubt that there are many in this county who sympathize with the objects of this new association in their endeavour to stimulate the study of the peculiar features and movements of the heavenly bodies. But this cannot be efficiently done without steady and continuous telescopic work with fixed instruments, and I am rather surprised that there is no public or private astronomical observatory of any pretension in Devonshire and Cornwall, west of the Rousdon observatory, near Lyme Regis.

Although astronomy gives ample opportunities for the exercise of the imagination when we are dealing with hypotheses concerning the probable composition and movements of the heavenly bodies hundreds of billions of miles away, yet in many of its branches it is very far from being purely a speculative science; at any rate the assertion of some that it is so is totally misleading, so far as regards the great fundamental laws of gravitation which govern the motions of all celestial bodies. But in comparison with the more practical sciences dealing with terrestrial elements, such as chemistry, geology, and mineralogy, astronomy must always appear somewhat dependent on the imagination of the observer, for the objects of his scrutiny are usually far too distant to ascertain their true characteristics without having some recourse to speculative analogy. How different all this is in chemistry and other experimental sciences. Here the experimenter has no occasion to go beyond what he has before him, as he has the advantage of always being certain of the discoveries that he makes. All that he has to do, if he is in doubt, is to repeat his experiment, and thus he can make sure of the effect of his discovery. Many of you probably will partly agree with the remarks made recently by the Marquis of Salisbury, when addressing the Chemical Society at their late Jubilee meeting, "that of course when a man discovers what happened fifty millions of years ago, it is not so easy to be exactly accurate as to the nature of his discovery; and when a man discovers what is going on fifty billions of miles away, although the discovery may be probable, it certainly has not the character of certainty that attaches to the discovery of a man who can go back to his laboratory and repeat his experiments. For it must be acknowledged that astronomy is largely composed of the science of things as they probably are, and that geology consists mainly of the science of things that probably were a long time ago, and chemistry is the science of things as they actually are at the present time." Whatever truth there may be in this comparison, his lordship, who is himself a distinguished practical chemist, forgets that in the present advanced teachings of chemistry, the chemical imagination is essentially mathematical, for the formulæ deduced from analysis ordinarily give very little explanation of the reason why the combination of elements has

certain properties. Two substances having different properties not uncommonly give, on analysis, formulæ almost identical. Hence chemists endeavour to obtain a correct grouping of the elements, as well as of their quantitative proportions, and in this operation the scientific imagination has most arduous work to perform.

But though imagination must necessarily enter deeply into some astronomical problems, it is a very different thing from the faculty that substitutes conjecture or speculation for ascertained fact. Original scientific research in all its branches could scarcely be carried on without bringing the imaginative powers into action, or we could have none of the fruitful yet purely tentative theories by which the results of research are systematized. Sometimes a certain number of facts may be joined together to form an intellectual frame-work, from which the scientific imagination may, by analogy, carry it into the neighbouring region of the unknown. These tentative theories may sometimes turn out to be wonderfully exact; at other times they may have to be abandoned, but in either case they offer most valuable assistance to the inquirer in researches of this nature. This style of reasoning is particularly noticeable in astronomy, especially in some deductions derived from spectrum analysis; in the problem of the motion and direction of the sun and its system in space; and in such a speculative subject as the new meteoritic hypothesis. In the consideration of all these delicate researches, imagination of some form must naturally enter very fully into combination with much that is derived from undoubted facts capable of scientific explanation.

Imagination, however, has very little part in our conceptions of the movements of the sun, moon, and planets in their respective orbits. These have been determined with an accuracy almost marvellous, the proof of which is daily presented to our minds by the never failing recurrence of the various astronomical phenomena at the predicted times given by calculation. So perfect are the existing theories of the movements of the different members of the solar system, that the positions of the sun and moon may be ascertained for any given moment in the past, present, or future, within a fraction of a second of time, while those of the planets may also be determined within very

small limits. The construction or improvement of these theories from the comparison of the observed and tabular places obtained over a long series of years, is the highest class of modern astronomical research, and it is only undertaken by mathematicians specially conversant with gravitational astronomy.

Perhaps I could not illustrate more clearly the perfect reasoning employed in some of these difficult problems of mathematical astronomy, than by referring to that great triumph of human intellect which culminated in the discovery of the planet Neptune, the most distant known member of the solar system. The problem was indeed a difficult one to solve. For if we wish to determine in what way two known planets of given distance, mass, and other ascertained elements will affect each other, the most skilful mathematicians sometimes fail in explaining certain marked peculiarities in their movements, although they are necessary consequences of the relations already known to exist between the two bodies. How much more difficult then it must be to infer from the observed irregularities in the motion of one planet, the distance, mass, and position of another planet hitherto unknown. This was, however, the problem that two mathematicians independently attempted to solve.

Since the publication in 1821 of M. Bouvard's tables of Uranus, the apparently great irregularities in the motion of this planet caused considerable interest, and various explanations were suggested to account for this irregular motion. About the year 1843 it occurred to Mr. J. Couch Adams, a name honoured by all Cornishmen, who had just taken the highest mathematical honours at Cambridge, and shortly afterwards to M. Le Verrier, of Paris, that by taking these apparent deviations from the planet's true motion as a basis of calculation, they might be able, on the assumption that the irregularities were produced by perturbations caused by the attraction of an exterior planet, to point out, by an inverse process of calculation, the exact position in the heavens where such an unknown attracting body would probably be found. Each of the two astronomers was fully convinced in his own mind of the reality of the problem, a belief afterwards confirmed by the discovery of the suspected planet very near the identical places in the heavens indicated by them.

In this marvellous manner, Neptune, the fourth of the major planets, was added to the known members of the solar system, and the perturbations observed in the motion of Uranus were ever after duly accounted for. Thus it was Sir Isaac Newton who explained the laws of universal gravitation, by which the heavenly bodies move in space; while it was reserved for Adams and Le Verrier to interpret these laws, and to indicate where a hitherto unknown planet could be found. Newton recognised laws not previously explained, and Adams and Le Verrier, by the highest mathematical analysis, inferred from them the existence of a world that had never before been seen as a planet by the human eye.

From the preceding remarks we may easily conclude that the science of astronomy must be considered as pre-eminently one of calculation and prediction—calculation of the past and prediction of the future. The first object that enters the astronomer's mind is therefore to extract laws and numerical elements from the phenomena that have occurred; while his second object is to apply these laws on the assumption of their invariability to the phenomena that will occur. By this means, any error that may have been committed in these fundamental assumptions can, by a comparison of the predicted with the corresponding observed results, be accurately ascertained. If we examine successive stages in the history of physical astronomy, we shall find that in all the various forms which the science has taken at different periods, we have certainly presented to us, either the struggle of reducing laws and elements to agreement with new phenomena, or the anxious search for some hitherto neglected causes of discordance, such as the effect of the perturbations on the motion of Uranus, produced by the powerful attraction of Neptune; or finally, the triumph of finding that assumptions were well founded, and that the agreement between observation and theory is sufficiently exact. The last of these conditions has been amply verified by the most recent investigations of the lunar and planetary theories, which now represent the motions of the sun, moon, and planets, sufficiently near for all practical purposes.

This intellectual advance in theoretical astronomy is owing, in a great measure, to the noble work of M. Le Verrier, who

devoted most of his life to the examination of the theories of the movements of the earth and the large planets from Mercury to Neptune. Prof. Newcomb and Mr. G. W. Hill, of Washington, have also been employed on similar researches. The former has exhaustively treated the theories of Uranus and Neptune, and the latter has very recently published an exposition of those of Jupiter and Saturn. These important investigations are the results of the most profound mathematical research based on a comparison of the calculated with the observed places of each planet.

The difficult problem of ascertaining the distance of the sun from the earth has specially occupied the attention of astronomers during the last thirty years. Several investigations by different methods have been undertaken, but the most popular was the observation of the transits of Venus across the sun in 1874 and 1882, both of which were utilised for this purpose. Since Dr. Halley in 1716 drew the attention of the Royal Society to this question, the transits of Venus have been generally considered to be one of the best methods for determining the value of the solar parallax, or the angle produced by the earth's semidiameter as viewed from the sun. Perhaps not many here to-day are aware that the first voyage of the celebrated Captain Cook was organized principally for obtaining observations of the transit of Venus in 1769, on which occasion he was successful on the shore of the island of Tahiti, still known as Venus Point. When my attention was first directed to astronomy implicit faith was placed in the distance of the sun as determined in 1824 by Encke from a discussion of all the observations made of the transits of 1761 and 1769. Prof. Hansen, of Gotha, while employed on his investigations on the lunar theory, found that in order to satisfy the refined observations of the moon made at Greenwich, it was necessary to make a considerable increase in Encke's value of the solar parallax, and consequently, a corresponding decrease in the distance of the sun. Le Verrier also found that to reconcile some discrepancies in his planetary theories, a larger solar parallax was required. Some recent determinations of the velocity of light also pointed to the same conclusion. Much was therefore expected from the two transits of Venus in 1874 and 1882, both

of which were observed successfully at the principal stations. The value of the solar parallax determined from all the observations is about 8″·80, from which the mean distance of the sun from the earth is calculated to be about 92,885,000 miles. Prof. Newcomb and Mr. Michelson have since made independent determinations of the velocity of light per second, from which they have deduced a value differing very little from that determined from the transits of Venus. You may easily imagine how difficult a problem the astronomers have had to solve, when it is considered that a second of arc is only equivalent to the angle subtended by a ring one inch in diameter, when viewed at a distance of more than three miles, and the correction to the solar parallax is just one-third of this. Or it is what a human hair would appear to be if viewed at the distance of 150 feet. Such are the minute quantities with which astronomy has to deal. If then a second of arc is so minute a measurement, what must we say when this second is again divided into a hundred parts, every one of which represents 100,000 miles in the distance of the sun. And yet this almost mathematical accuracy is hoped to be obtained eventually from the combined series of all the observations of the recent transits of Venus over the disc of the sun.

A total eclipse of the sun is another phenomenon which always creates much interest, as on these occasions most valuable observations are made on the constitution of the chromosphere and corona, which are usually visible during totality, but at other times hidden by the glare of sunlight. In England, total eclipses of the sun seldom occur, and then only at long intervals. The last occurred in 1724, and the next will not take place until 1927. Before the red solar prominences were found to be observable in sunlight, by means of the spectroscope, the expeditions formed for viewing an eclipse were of a more interesting character than the purely scientific expeditions of the present day; as now the attention of the observers is usually confined to spectroscopic and photographic observations of the corona and prominences, and thus all the sentimental beauty of the phenomenon is sacrificed to pure science. In 1851, I had the good fortune of witnessing a total eclipse in Norway, and the impressions then fixed on my mind of its sublime character, are

very vivid even now, after an interval of so many years. The beauty of the corona on these occasions, especially when the sky is free from cloud, is always admired for its silvery whiteness; while in the telescope rose-coloured solar prominences, consisting of incandescent hydrogen gas, are usually seen shooting out from the sun at the edge of the dark body of the moon, to an occasional height of 100,000 miles or more. At Christiania, the dark shadow-path was seen to approach gradually from the west, and after the few minutes of total darkness, it was noticed to pass as gradually away towards the east. The varying effects of light and shade on the landscape and on the waters of the Fiord was a sight worth a long journey to see.

Since the construction of the powerful space-penetrating telescopes, with which almost every observatory of importance is now furnished, great attention has been given to the delineation of the special features observed on the discs of the planets Mars, Jupiter, and Saturn. The changes of detail that are continually visible on the surfaces of these interesting planets show that they are subject to atmospheric storms of far greater magnitude than what we experience on the earth. For example, we see on Jupiter all the signs of great atmospheric disturbances, produced by forces indicating the existence of very strong winds, bearing some analogy to our trade winds. The cloud-like formations are sometimes seen to change so rapidly in shape, that they can hardly be accounted for except by supposing that large quantities of rain has fallen, and thus new clouds would naturally be formed; or else that great cloud-masses have been driven along with enormous rapidity by immense currents of air moving with the velocity of a hurricane. It has been calculated that this velocity of the wind cannot be less than two hundred miles in an hour. The physical features of Jupiter are interesting subjects of study to the amateur astronomer, as all the variations in the form of the belts are easily distinguished in most ordinary telescopes; and what these features are have been well shown in most of the beautiful drawings that have been made of this giant planet in recent years. During the last twelve years an enormous red spot of an oval form has been peculiarly attractive. Other spots of a reddish colour, and some almost a pure white, are occasionally noticed, but these are not

usually of so permanent a character as the great red spot; which, however, at the present time appears to be on the wane. On Saturn also, faint streaks of light and shade have been observed on the ball, leading us to infer that this planet is likewise surrounded by an atmosphere of some kind, subject to all its attendant meteorological phenomena. But these two distant planets do not exhibit so many permanent markings as may be observed on the surface of Mars, which of all the planets has the most terrestrial appearance. The markings on Mars are very distinctly defined, forming apparent continents, islands, seas, and inlets. The brightest parts, excepting the white patches near each pole, have a faint ruddy tint, while over-spreading the continents networks of fine lines have been noticed, to which the name of canals have been given.

All the planets from the earth to Neptune are now known to be attended by one or more satellites. The two moons of Mars were unknown before 1877, when they were discovered by Prof. Asaph Hall, at the Washington Observatory. To an observer on Mars they must present a remarkable appearance in the heavens, as the nearer of the two revolves around the planet in less than eight hours, and the more distant satellite in about thirty hours, at a distance of only 4,000 and 12,000 miles respectively from the surface of Mars. The telescopic view of Jupiter and its four attendant moons always affords considerable interest, especially the continual change in the positions of the different satellites relatively to themselves and their primary. If we may be permitted to imagine that there are any intelligent beings on Jupiter, we may almost picture to ourselves the very startling nocturnal phenomena presented to their view. The nights must always be favoured with moonlight, for when any one of the satellites is absent from the visible firmament, one at least of the others is almost certain to be present. Frequently, the surface of Jupiter is enlightened by three moons at the same time, all exhibiting different phases. The changes that are continually taking place in the Jovian aspect as the planet rotates on its axis, taken in combination with the constant variations in its cloudy envelope, must be singularly impressive and suggestive to any reasoning creatures, supposing that there are such on these four attendant worlds circling around Jupiter.

Some recent photographs that I have seen exhibit the peculiar spots and other features of this planet with a remarkable clearness of definition.

But perhaps one of the most interesting of all the recent discoveries, relating to the solar system, is that of the minor planets, of which up to the present time 309 have been detected. These minute bodies, supposed to vary in their diameter from about twenty to two hundred miles, are all included between the orbits of Mars and Jupiter. The first four of the minor planets were discovered near the beginning of the present century, and for sometime were considered to be fragments of a large planet shattered to pieces by some internal convulsion; but owing to the great diversity in the observed inclinations and other elements of their orbits, this hypothesis is hardly tenable. I remember very distinctly the enthusiasm with which the discovery of a fifth member of the group in 1845 was received, the first of the yearly discoveries that have been made to the present time. While watching one of these minute objects in the transit-circle at Greenwich, it has always appeared to me that the general truth of the fundamental laws of astronomy is made apparent, when the faint point of light representing a minor planet faithfully enters the field of view at the exact moment, and in the exact position in the heavens to which the telescope is directed, as predicted by the computer, with the same accuracy as the large planets. The elements of the orbits of all these 309 minor planets have been calculated, some of them with great precision.

Minor planets, however, are not the only minute bodies circulating in orbits around the sun, for within the confines of our solar system, swarms of meteors are now known to move in periodic orbits, accompanied by comets travelling in the midst of the swarm. Comets and meteors are therefore supposed to be physically connected. Indeed, the elements of the orbits of several comets are found to be almost identical with those of corresponding streams of meteors, and spectrum analysis has proved that their elementary composition has much in common. Prof. Lockyer, however, has expressed an opinion that all self-luminous bodies in the celestial vault may probably be composed of meteorites or masses of meteoritic vapour, produced by heat

brought about by condensation of meteor swarms due to gravity, so that the existing distinction between stars, comets, and nebulæ, rests on no physical basis—all alike are meteoritic in origin, the difference between them depending upon differences of temperature, and in the closeness of the component meteorites to each other. These suggestive opinions of so distinguished an astronomer are deserving of every consideration, though scientific imagination must necessarily have an important influence in speculative questions of this nature.

I have remarked, on a former occasion, that the romance of astronomy is always a subject of attraction to early students of the stars, and that the study of the science is most fascinating when the object to be obtained is a real scientific acquaintance with the countless luminaries visible overhead on a clear autumn or winter night. But what I wish to do now is to pass over the romantic portions of the science, and to devote a few words on the connection of astronomy with our daily life. I shall thus be able to show you that although there may be some imagination employed in the solution of imperfect or doubtful data, astronomy is yet a necessary help to us all in our domestic and business occupations. Anyone can realize the great advances made in electrical science, for he is continually reminded of them by the practical benefits derived from the use of the electric telegraph and the telephone, but how few there are who connect astronomy with anything that is practical. And yet it is employed in various ways unknown to the general public. The clock-time exhibited by every public clock, by your household timepieces, and even by the watches in your pockets, would soon go astray were it not that the astronomer at Greenwich is ever referring his standard timepiece to the unerring great star-clock. Daily he is on the watch for an opportunity to make this necessary comparison, so that he may be in a position to disseminate true Greenwich time throughout the country. This is accomplished by means of an elaborate system of galvanic time-signals, which are transmitted from the Royal Observatory, at stated times, to all the principal post offices and railway stations in the kingdom, through the wires of the Post Office telegraph department. Time-balls, giving the correct time, are dropped daily at various places by a direct

signal from Greenwich; and two under the sole control of the Astronomer Royal are also dropped daily at 1 p.m., one at the Royal Observatory and the second at Deal. The dissemination of Greenwich time-signals has been the means of adding considerably to the punctuality of railway trains, as since the adoption of Greenwich time throughout the kingdom, no excuse can be made on account of the difference of clocks.

But if true Greenwich time is found to be essential in our home life, how much more necessary it becomes to the seaman when thousands of miles away from port. Let us see how the astronomer comes to his assistance. Just look for one moment into the chronometer room at the Royal Observatory. You cannot avoid being attracted by a universal buzz, reminding you of the hum of a beehive, for sometimes more than two hundred chronometers are stored here at one time, all of which are rated daily and kept ready for use in Her Majesty's ships when required. It is pleasing to know that the commanders of our noble ships may obtain one of these delicate chronometers, preserved and rated daily by astronomical observations, by which they are enabled to ascertain accurate Greenwich time when at sea. Without this information and the predicted positions of the sun, moon, and stars, given in the "Nautical Almanac," and derived from the refined theories of the mathematical astronomer, the seaman could never ascertain his true longitude and latitude at sea, but would have to rely on the primitive methods of navigation practised by the ancient mariner.

Astronomy is also employed in determining the figure of our globe, and the relative positions of points on its surface. By a comparison of the respective local clock-times found directly from observations of selected stars at two distant stations, the difference of longitude is at once found, and by observing on the meridian the altitudes of stars whose declination is accurately known, the latitude of any station can also be determined. Longitudes may be obtained by several astronomical methods, but the easiest, and at the same the most satisfactory, is by the observation of galvanic signals transmitted from one station to the other, the local clock-times and signals being recorded automatically on a chronograph at both stations.

The differences of longitude between most of the principal observatories have been determined in this manner.

I trust that I have now made it clear to you that though in the speculative branches of astronomy imagination may occasionally assist in forming conclusions from probably insufficent data, there are other and more important branches which rest on a solid and truthful basis, such as the well-proved theories of the movements of the sun, moon, and planets, in their respective orbits, and the numerous facts relating to the physical constitution of the heavenly bodies, many of which have been proved over and over again by different observers and methods of observation. Even an inexperienced star-gazer may soon be convinced of the reality of what he sees in his telescope as he scans the varying lights and shadows seen on the faces of the sun, moon, and planets. Astronomy is indeed a fascinating science to those who are sufficiently educated to appreciate and understand the general principles of the construction of the starry universe, and who are anxious to become interested in the movements and composition of the heavenly bodies.

And now, ladies and gentlemen, I cannot conclude this necessarily imperfect astronomical portion of this address, without impressing upon you the pleasing fact that however much has been unfolded to our minds by the remarkable activity of observers in all countries up to the present time, there is a strong indication that astronomical knowledge is still advancing from year to year. Most powerful telescopes, the like of which could hardly have entered into the minds of the astronomers of the last generation, are now constantly directed to the heavens in Europe, America, the Cape of Good Hope, and Australia, by men eager for discovery, and intellectually competent to turn to the best advantage whatever novelty they may see. As on our earth it has been proved that nearly every apparently rude element teems with animal life, so do the regions of infinite space teem with unexhausted wonders, requiring only the clear and intelligent mind, and the observant eye of the astronomer to detect. The works of creation are as boundless in the distant regions of the universe, as under our own eyes in this comparatively little world which we call the earth. Planets countless

in numbers probably still roll on in their courses around the sun unseen by man. We know that more than three hundred of these little asteroids are revolving in unerring orbits between Mars and Jupiter, and possibly many hundreds more may be discovered during the life of the present generation. Stars, the centres of other systems as boundless as all that we behold on the most brilliant night in winter, have been proved to possess the most mysterious peculiarities, some of which we may be able to explain, while the rest must remain to be deciphered by the advanced astronomy of the future.

But though astronomy may claim an antiquity reaching, by tradition, so far back as the time of Abraham, when the Chaldeans, according to Herodotus, gave the names to thirty-six of the principal constellations, much that is included in modern astronomy makes it comparatively a new science, if we consider the wonderful discoveries made during the last 120 years. However, astronomy is still advancing with giant strides, in company with many of the other physical sciences, and we entertain no fear for the future nor need we envy our descendants the enjoyment of the accumulation of observed facts, or the comprehensive grasp which they must naturally have of the science of the visible universe, compared with what we are enjoying near the end of the nineteenth century. It is sufficient for us to know that there is still good astronomical work remaining for us to do, while at the same time we may devoutly recognise the scantiness of our knowledge compared with the vast universe of created worlds, and humbly exclaim when we give an intelligent glance upwards to the starry heavens, "O Lord, how manifold are Thy works! in wisdom hast Thou made them all."

ANNUAL EXCURSION, 1891.

The Annual Excursion of the Royal Institution of Cornwall took place on Aug. 20th, and was as successful as such an enterprise could be in a continuous and heavy downpour of rain.

The party, which numbered over fifty, assembled at Wadebridge at half-past nine in the morning, took carriage and rode away for St. Breock Church. Very soon after the start the rain commenced to fall, and for the remainder of the day never ceased. The first halting place was St. Breock Church, where the members, met by the vicar (the Rev. W. P. P. Matthews), paused for a few moments to inspect an early slab commemorating, in Norman French, "Tomas le Vicarie de Nansegn," a curious armorial tomb of Vyell, and some Tredinnick family brasses. On through the rain the party then went to St. Petroc Minor Church, a beautifully decorated fabric, which was reopened for services after re-building in 1858. Among the relics which were inspected with interest was the Norman French slab of a certain Sir Roger, now lying under a low arch constructed for its reception on the north side of the sacrarium. It is a flat stone, with a simple floriated cross cut upon it in low relief, and surmounted by a tonsured human head. St. Petroc, the patron saint of the church, is said to have visited Ireland and thence crossed over to Padstow A.D. 518. He afterwards settled at Bodmin, where he died. The Rev. Viscount Molesworth, the vicar, courteously explained to the visitors the features of interest in the church. From this point, however, a large part of the programme, including a trip to Trevose Head, was, by common consent, abandoned, and a rapid drive was made to Padstow. One waggonette proceeded to St. Merryn, where its church was inspected. Major Parkyn had remembered his errant brothers and sisters, and they gladly found at Padstow the refection which had been reserved for them. Some of the party then rested, some walked to the battery, and others strolled about Padstow until half-past two o'clock, when, by invitation of Mr. Prideaux-Brune, they visited Prideaux Place, once known as Prideaux Castle, a

name in consonance with its castellated style. And in the old, old days it was called Gwarthendra. The present building is Elizabethan, and has not suffered much alteration. Carew describes it as "the new and stately house of Mr. Nicholas Prideaux, who thereby taketh a full and large prospect of the toune, haven, and country adjoining; to all of which his wisdom is a stay, his authority a direction,"—a tradition which is admirably maintained by the present highly esteemed representatives of that ancient family, Mr. and the Hon. Mrs. Prideaux-Brune. The house is believed to occupy the site of an ancient monastery, which was destroyed by the Danes, when, according to the Saxon Chronicle, they plundered and set fire to the town.

The company lunched, through the hospitality of Mr. Prideaux Brune, in the old oak-pannelled dining hall of the mansion; and after luncheon, Dr. Trollope, the Bishop of Nottingham (suffragan of Lincoln), read an interesting paper on "the antiquities of the neighbourhood." He alluded to a volcanic hill and submarine forest on the other side of the river. He suggested that the forest was now submarine, by reason of the sinking of the ground, and not because of the encroachment of the sea. He mentioned the finding of many remains in that neighbourhood which he considered pointed unmistakably to that part of Cornwall, at all events, having been occupied by the Romans. The Bishop also alluded to the shifting of the sands on the other side of Padstow harbour, and the discovery of the remains of the ancient church of St. Enodoc.

There was no time to discuss the Bishop of Nottingham's paper; but time was of course found to thank Mr. Prideaux Brune for his hospitality. Mr. Iago was the first to express the gratitude of the company for such a haven of rest and refreshment as Prideaux Place proved to be after the storms of the day. He observed also that he had long known Bishop Trollope as a writer on Cornish antiquities, and alluded to the recent discovery of another distinct trace of Roman remains in North Cornwall of the time of the Emperor Licinius. Canon A. P. Moor then proposed a vote of thanks to Mr. Prideaux-Brune for his liberal and graceful hospitality, and recalled a similar reception the

society had last year at the hands of Mr. Pendarves Vivian at Bosahan, and looked back also to the generous manner in which they were once entertained at Cotehele by the Earl of Mount Edgcumbe. Mr. J. R. Collins, Mayor of Bodmin, seconded the vote of thanks, and made some humorous observations which were appreciated. He expressed a hope also that they would soon be able to come to Padstow by the North Cornwall line. Mr. Prideaux-Brune, in reply, said it gave him great pleasure to see them there, and hoped the next time they were able to get to Padstow they would have better weather.

There was unfortunately no time to view the house (with its many interesting portraits and its fine library) or the grounds, in which there are some old crosses and other remains of antiquity.

A brief visit was paid to the fine old church of St. Petroc, on the way down to the conveyances. There the Bishop of Nottingham read another interesting paper. Viscount Molesworth's church is St. Petroc Minor, or Little Petherick, so Padstow is Petroc Major or Great Petherick, and there are dedications to St. Petroc also at Bodmin, Dartmouth, and Exeter. St. Petroc is believed to have been a British missionary, who came across to Padstow in 518, and settled and died at Bodmin in 564. According to the legend, he came across the sea on a millstone; but Bishop Trollope thought that might mean that he came across with a cargo of millstones, or that his ship was said to be like a millstone.

The site of the church was evidently the very old site of a sacred building. The remains of an ancient cross near the entrance to the churchyard he attributed to the Saxon era; and there was a very beautiful cross of a later date. But the present building was perpendicular, there was no trace of Norman work in it. The tower was of 14th century style. The kind of flamboyant tracery in some of the windows of the south chancel aisle, he thought, did not indicate any different period, but was merely the fancy of the architect, or of the benefactor for whom the aisle (as a chantry chapel) was built. The Bishop called attention also to the pulpit, the new screen, and to two old bench-ends which have recently been discovered and made into a seat for the sacrarium. These old bench-ends are very finely

carved, one of them depicting a fox preaching to a congregation of geese. The Rev. J. Core, the curate-in-charge, was also present, and pointed out some of the features of interest, including brasses of some former vicars, one dated 1421, and the beautiful marble work above the altar, done by Mr. England, a Padstow workman.

After leaving the church, came the ride back to Wadebridge, still more or less in the wet, and in due course the train took the excursionists to their respective destinations. The company included the following:—

Mr. and the Hon. Mrs. Prideaux-Brune; the Bishop of Nottingham; the Hon. Mrs. Davies-Gilbert, of Trelissick; the Misses Prideaux-Brune, Rev. E. Prideaux-Brune; Rev. J. Core, Padstow, acting for the vicar; Rev. Canon Moor, St. Clements; Rev. A. H. Malan, Altarnon; Rev. F. Eld, Worcester; Rev. W. Iago and Mrs. Iago, Bodmin; Mr. J. R. Collins, Mayor of Bodmin; Colonel Parkyn, Major Shanks, R.M., and Dr. and Mrs. Salmon, Bodmin; Mrs. Paull, and Miss Lillie Paull, Bosvigo; Mrs. E. Sidebotham, Misses J. L. Stokes, Ekless, Smith, Pinkett, Bodmin; Tomn, Ferris, M. Langdon, Truro; Mrs. Casey, Dublin; Mr. and Mrs. R. Whitworth, Mr. and Mrs. A. Blenkinsop; Mr. and Mrs. A. Cragoe, Penhellick; Messrs. Hamilton James, S. H. James, Mozambique; Henry Barrett, John Barrett, W. J. Clyma, Samuel Pascoe, Joseph Rogers, Stephen Rogers, F.G.S., Theodore Hawken, H. Buck, Thomas Clark, O. I. Blackford, F. E. Sach, Truro; Mr. and Mrs. Hawken, and Mr. F. Cresswell, Liskeard; Mr. F. W. Michell, C.E., Redruth; Mr. R. Palk Griffin, Padstow; Mr. and Mrs. Wilson, Mr. C. H. Collings, and Mr. H. J. Sanderson, London; Major Parkyn, F.G.S., Hon. Sec., Mr. H. Crowther, F.R.M.S., Curator. To Major Parkyn and to the Rev. W. Iago thanks are particularly due for directing the expedition, which, but for the weather, would have been a most successful one.

Royal Institution of Cornwall.

72ND ANNUAL GENERAL MEETING.

The Annual Meeting of the members of the Royal Institution of Cornwall was held on Tuesday afternoon, November 24th, 1891, in the Museum Rooms, the chair being taken by the Rev. W. Iago, B.A., Hon. Secretary for Cornwall of the Society of Antiquaries, London, and Vice-President of the Institution, who presided in the absence of the retiring President, Mr. Edwin Dunkin, F.R.S., Past-President of the Royal Astronomical Society.

The Chairman regretted the absence of their retiring President, who had performed the duties of his office with such very great success and benefit to the Institution. The Council recommended the appointment of Sir John Maclean, F.S.A.,—the well-known antiquary, the author of "The History of the Deanery of Trigg Minor," and other valuable works,—but he regretted that the prevailing influenza prevented his attendance that day. Sir John had written saying, although he had been elected president of other societies, he felt the greatest pleasure and honour in being chosen to occupy the presidential chair of this Royal Institution, Cornwall being his native county. It was at their suggestion that Sir John Maclean was not among them. They were not willing to risk the health of so valuable a president as Sir John would be, by his taking a journey in the present weather and coming into a district where influenza prevailed. Sir John wrote taking their suggestion and thanking them for it. Since they met last their worthy Bishop had left Truro, and now a new Bishop had taken his place. The first Bishop of Truro was one of their very best members. His successor was also a member, and, having had the honour and privilege of having the two Bishops as members, they looked forward to the time when Dr. Gott would also be enrolled. He (Mr. Iago) had already invited the Bishop to join them, and he would have been there, had he not been engaged that day with a confirmation at St. Just.

Later on, Archdeacon Cornish announced that the Bishop would be pleased to become a member.

Major Parkyn, the Hon. Secretary, read the Annual Report.

REPORT OF THE COUNCIL.

The Council of the Royal Institution of Cornwall, in presenting their 73rd Annual Report, have much pleasure in congratulating the members on the great advance in all branches of the Institution since the last annual meeting, for whether they regard the continued progress made by the Curator in the better display of the objects in the Museum, the general work of his classification, the many valuable additions to the collections, or the numerous gifts to the library, it must be evident to every one that the Society is passing through a period of progress and prosperity.

Death, however, has been more than usually busy in the ranks of the members since the last annual report, and the Society have to lament the loss of Mr. N. Whitley, F.R.Met.S., Mr. H. M. Jeffery, M.A., F.R.S., the Right Hon. Sir Montague Smith, Mr. W. Sincock, Mr. George Williams, and Mr. Charles Harvey.

Mr. Whitley's connection with the Institution dates back some 40 years, during the whole of which time he took an active and leading part in the affairs of the Society; he was a valuable and voluminous writer for the Journal, for many years he was one of the Secretaries and filled successively the offices of Member of Council and Vice-President. It will be unnecessary here to dwell more at length on his services to the Institution, as an obituary notice is promised for the next number of the Journal.

Mr. Jeffery joined this Society immediately on returning to take up his permanent residence in his native county. It may be said of him that he threw himself heart and soul into the work of the Institution, and as a Member of Council was most regular in his attendance at the Meetings; indeed, it was a very rare thing for him to be absent from them. It is somewhat remarkable that so abstruse a mathematician should in his anxiety to help on the objects of the Society and to assist in the literary work of the Council, have taken so much interest in archæological and topographical history, but we have only to

refer to his printed contributions in the Journal of the Royal Institution, to prove that his mathematical mind could be brought advantageously to bear on the elucidation of local history as well as on abstract science. As stated just now in reference to the late Mr. Whitley, so in the case of Mr. Jeffery, an obituary notice of some length will be written for the Journal.

The Right Hon. Sir Montague Smith, the eminent judge, was a very old subscriber, and when opportunities were afforded him to be present at the Spring and Annual Meetings he generally attended.

Mr. W. Sincock, of Melbourne, Australia, was introduced to this Society by Sir John Maclean, the President elect, and readers of recent numbers of our Journal will have noticed the valuable series of papers he contributed on the "Landlords of Cornwall in early Mediæval Days."

Mr. George Williams, of Scorrier, we regret to say, was very soon removed by death after becoming a member. It is satisfactory, however, to note that his son has come forward to fill his father's place.

The sad list closes with the loss of Mr. Charles Harvey, the youngest brother of Mr. Robert Harvey, the munificent benefactor of this Institution. He was a young medical man of great promise returning to this country from Chili in search of health, and died very suddenly at New York on his way home.

It is pleasing now to dwell for a few moments on the great accession of members. During the past year no fewer than 25 new subscribers have joined, and this has been accomplished without any pressing solicitation. It is probable that in no other year in the history of this Institution has there been such a large increase of members.

The Meteorological observations have been carried on by the Curator with his usual care, and the results have been communicated to the public through the press of the two counties, in a monthly letter, and from the testimony received from the reading public it is evident these letters have been much appreciated.

The Annual Autumn Excursion (a detailed account of which will appear in the Journal) took place in the Wadebridge and Padstow district. The weather proved most unpropitious, but

no ill effects are known to have ensued. The utmost kindness and hospitality were extended to those who took part in the expedition, by Mr. and the Hon. Mrs. Prideaux-Brune. The great Hall at Prideaux Place was an agreeable refuge from the heavy rain. The large number of our members and friends, who thronged it, were bountifully entertained by their kind host and hostess. An additional pleasure was also experienced when the Bishop of Nottingham, Dr. Trollope, the well-known antiquary, imparted to the guests much valuable information relative to Padstow, its Church, and neighbourhood. It was intended that Pawton Cromlech, Nanscowe Stone, and Trevose Lighthouse should also be reached, but those points had to be abandoned. The Rev. Viscount Molesworth and the Rev. W. P. Pardoe Matthews kindly shewed the interior of their churches, and gave such particulars as conduced to the purposes of the visit. Notwithstanding all difficulties caused by exceptionally severe atmospheric disturbance, good humour and cheerfulness prevailed.

To Mr. J. Claude Daubuz, High Sheriff of the County, a highly esteemed member of the Institution, the sincere thanks of the Society are due for having presented some handsomely carved oak—formerly the stall or state-chair of the Mayors of Truro, in old St. Mary's Church,—in order that it may be used in the construction of a suitable official seat for our future Presidents. Such a distinctive chair has long been required. Mr. Daubuz's gift will therefore not only prove useful, but will be the means of preserving in a satisfactory manner an interesting relic of fine proportions and workmanship, connected with many associations relating to the past history of the city.

The Council have again to thank Mr. John D. Enys, F.G.S., for his presentation of the Report of the British Association Meeting as soon as issued.

It is gratifying to find that the interest of the public in the Museum shews no falling off, and that a steady increase in the number of visitors is maintained. During the past year the numbers shew:

Admitted Free	3,894
By Ticket	239
By Payment	348
	4,481

Further progress has been made in the Geological room in forming a collection of typical mineral ores from mining districts. The sets so far arranged and tabulated are blue grounds and matrices from the Kimberley Diamond Mines, presented by Dr. Winn, London. A varied and interesting set of minerals from the mines of East Germany, the Hartz, and Italy, by Major Parkyn, F.G.S., one of the Honorary Secretaries. An extensive collection of copper and other ores from the Bolivian Andes, by Mr. Robert Harvey, J.P., of Dundridge. Tin and copper ores from Spain, by Mr. Richard Pearce, F.G.S., H.B.M. Vice-Consul at Denver, Colorado. A large and valuable set of minerals from Rio Tinto Mines, Spain, and another from mines in Portugal, by Mr. James Osborne, C.E., F.G.S., Truro. An interesting series of specimens also, from the sett of the Uranium mines at St. Stephens, by the Company, per Capt. W. R. Thomas, F.G.S. The arrangement of mine minerals has been devised by the Curator to meet the wishes of practical miners who desire to see collective sets of ores from specific mining localities. The minerals of the various districts are grouped irrespective of kind, so that by the mixing together of country rocks and their associated minerals, the miner may more easily recognize the appearance of certain mineral ores he may meet with abroad. In the Geological department an alteration has been made for the better display of the fossils. The specimens are being mounted on colored tablets and specifically labelled. The flat shelves on which they rested in the upright cases have been taken out, and inclined shelves substituted, with narrow strips of wood running along in front to keep the tablets in place. The cases also have been divided. so that the fossils in the collection will be placed in proper geological sequence—a whole case being retained for Cornish specimens. An excellent collection of Eocene fossils from New Zealand has been presented by Mrs. A. P. Moor, St Clements, and arranged in the one of the cases.

A case has been set apart too in the Geological and Mineralogical room for the display of a set of Cornish Rocks, and to this, in addition to the specimens the Institution already possessed from various parts of the county, others beautifully polished, have been contributed by Mr. Thomas Clark, Truro; whilst Mr. Howard Fox, F.G.S., Falmouth, has presented types of new kinds of rocks from the Lizard district.

Considerable progress has been made in the re-arrangement of the recently acquired shells, and half our former collection has been removed from the Geological room to the Zoological room, and there newly mounted on tablets and labelled in accordance with the other collections. The shells formerly possessed by the Institution, to which Mr. B. W. Tucker, of Trematon Castle, and Mr. John H. James, of Truro, so largely added, have been supplemented by the more recent gifts of Mrs. Sharp, of Kensington Gardens, London, and Mr. Ralph Baron Rogers, of Falmouth; and those gifts are being incorporated in the collection as the shells are being laid out.

Most of the upright cases in the Zoological room have been cleaned and re-painted; in two of them a special series of egg cases has been fitted, and doors of an improved make contrived to close over them to keep out the light. In the cases are to be placed the collections of eggs given by Mr. Richard Pearce, F.G.S., and Mr. A. P. Nix.

At the western end of the same room in other upright cases, protected by similar doors, a set of British Butterflies and a few Moths, also recently given by Mr. Richard Pearce—have been arranged, and are much admired by visitors.

Several additions of an educational character have yet to be made to the Butterfly case to make the collection still more useful to students. The Curator has compiled a label list for use in arranging the Rhopalocera, or Butterflies, a copy of which will be issued in the Journal, and sold in the Museum for the use of students.

A more extended application has been made of labelling the Museum specimens since the last report was issued. Variously coloured tablets have been adopted for several departments, and their mountings under the heads of Conchology, Geology, Mineralogy, Petrology, Mining and Archæology, are beginning to shew in the Museum.

The past year has seen the issuing of three new guides to the Museum, one on the Pozo Inscribed Stone, the cost of which has been defrayed by Mr. Robert Harvey, another on Anthony Payne, and a third on the British Butterflies; as these are issued as cheaply as the Institution can afford to supply them, it is hoped they will meet with a ready sale to such as are interested in the

Museum, or wish to preserve at home some record of its interesting contents. The Curator will endeavour to issue from time to time other guides to the various departments.

It is gratifying to learn that the classes formed last winter for the study of various scientific subjects were very successful; the attendances good, and the grants from the Science and Art Department high. By the 17 students who sat in the examinations no fewer than 27 certificates were obtained. Similar classes are again this winter in full operation under the County Council, and Mr. Crowther is engaged in giving in these rooms lectures on Geology, Mineralogy, Steam, Mechanical Engineering, Botany, Hygiene, and Shorthand. The classes are well attended, some 70 students availing themselves of this opportunity of acquiring knowledge.

It is with pleasure that the Council notice the appointment also of their Curator as Lecturer on Mining, and on the Raising and Dressing of Ores at the Mining School, established by the County Council at Chacewater.

The President, Mr. Edwin Dunkin, F.R.S., Past-President of the Royal Astronomical Society, having filled the office for two years, the Council have much pleasure in proposing Sir John Maclean, F.S.A., another Cornishman, as his successor.

They also propose the following as Vice-Presidents for the ensuing year:—

Dr. Jago, F.R.S.	Ven. Archdeacon Cornish, M.A.
Rev. Canon Moor, M.A.	Rev. W. Iago, B.A.

Mr. Edwin Dunkin, F.R.S., F.R.A.S.

Other Members of Council:—

Mr. John D. Enys, F.G.S.	Mr. R. M. Paul, M.A.
Mr. Howard Fox, F.G.S.	Mr. Thurstan C. Peter.
Mr. Hamilton James.	Mr. E. Rundle, F.R.C.S.I.
Rev. A. H. Malan, M.A.	Rev. A. R. Tomlinson, M.A.
Mr. F. W. Michell, C.E.	Mr. Robert Tweedy.

Mr. A. P. Nix, as Treasurer.

Mr. H. Michell Whitley, F.G.S., and Major Parkyn, F.G.S., as Honorary Secretaries.

On the motion of Mr. J. Claude Daubuz, seconded by Col. George J. Smith, it was resolved that the Report be received, adopted, and printed.

Mr. Crowther then read the list of presents to the Museum and Library.

PRESENTS TO THE MUSEUM.

Specimen of black Quartz from St. Dennis	Capt. Bryant, Truro.
Nest of Longtailed Titmouse, *Parus caudatus*, L.	A. J. Edwards, Perranwharf.
American King Crab, *Polyphemus occidentalis* ...	William Harris, New York.
Common Mouse, attacked and killed with mouse flavus	Robert Tweedy.
Box of Fungi, *Lachnea coccinea*, Jacq.	J. Brown, Wadebridge.
Two Micro-slides, Mouse Flavus and *Saccharomyces aceti* ... ... Zoophyte, Sea Beard, *Antennularia antennina*, Turton, from Falmouth, attached to stone ...	Dr. Rundle.
Specimen of Common Weasel, *Mustela vulgaris*, L. Specimen of Stoat, *Mustela erminea*, L. ... ... White example of Stoat ... ... Great Black-backed Gull, *Larus marinus*, L. ... Lizard Minerals, Potstone in mass and in section ... Fossils from Bedruthan Steps ... ... Specimens of Polished Serpentine	Thomas Clark, Truro.
A very interesting series of Eocene Fossils from New Zealand, including the following genera of Mollusca :—*Pleurotoma*, *Voluta*, *Murex*, *Cassidaria*, *Mitra*, *Buccinum*, *Conus*, *Triton*, *Fusus*, *Pyrula*, *Ranella*, *Trochus*, *Eulima*, *Natica*, *Dentalium*, *Scalaria*, *Terebra*, *Marginella*, *Turitella*, *Cypraea*, *Solarium*, *Emarginula*, *Pecten*, *Pectunculus*, *Arca*, *Limopsis*, *Leda*, *Chama*	Mrs. A. P. Moor, St. Clements.
Unique specimens of Minerals from S.E. Norway:— Scapolite; Hornblende and Apatite, Sphene and Horblende, from Monejkjand, Sphene and Scapolite, and Sphene, from Bakken, Rutile crystals, on gossan and quartz, from Vaereland	Arthur L. Collins, London.
Fungus, *Dædalia unicolor*, from Penmere ... ... Minerals from the Lizard :—Picotite in Serpentine, Lankidden Cove ; Potstone, Polcornick ; Porphyritic Hornblende Schist, Bass Point ; Porphyritic Diorite, Cavonga ; Aluminous Serpentine (Pseudophyte), Kynance	Howard Fox, F.G.S., Falmouth.
Lancelot, *Amphioxus lanceolatus*, dredged in Veryan Bay	R. Vallentin, Falmouth.

Specimen of Male Brambling, *Fringilla montifringilla*, L.	F. H. Davey, Ponsanooth.
Specimen of Bewick's Swan, *Cygnus Bewickii*, Yarrell	F. King, M.R.C.S., Truro.
Framed Portrait of the late Nicholas Whitley, C.E., Truro, Honorary Secretary of the Institution, 1859-79. Vice-President, 1880-84	Mrs. Whitley, Penarth, Truro.
Liassic Ammonite	Thurstan C. Peter, Redruth.
Tiles found in Luxulyan Church in 1878; of Spanish make, about 1350-1400	Rev. J. Kendall Rashleigh, M.A., St. Stephens.
The sum of £5 5s. 0d. spent in the acquirement of British Lepidoptera and British Birds' Eggs	Rich. Pearce, F.G.S., Denver, Colorado.
Two light-colored varieties of the Black Crow, *Corvus corone*, L.	Walter Carnsew.
Crystallized specimens of White Arsenic	Stephen H. Davey, Ponsanooth.
Antique Lamp, dug from beneath a statue of Rameses II, at Bedrechin, Egypt, by Major Bagnold, R.E. ... ... Oyster on Pipe Bowl	John Burton, Falmouth.
Specimen of Cassiterite from Godolphin Mine, Breage	Rev. S. Rundle, M.A., Godolphin.
Large collection of Minerals from the Bolivian Andes: Native Copper, Atacamite, Selenite, Gypsum, Galena, Azurite, Malachite, Brochantite, Calcite, Felspar, Bornite, Calcopyrite, Silver Lead, &c.	Robert Harvey, J.P., London.
Minerals from the Rio Tinto Mines, Spain; Chalcopyrite, Galena, Blende, and several interesting specimens of iridescent Limonites	James Osborne, C.E., F.G.S., Truro.
An interesting series of Fossils, including:—*Beleminites*, *Spongilla*, *Ananchytes ovatus*, *Cidaris sceptifera*, *Terebratula*, *Rhynchonella*, *Spondylus spinosus*, *Lamna elegans*, *Otodus obliquus*, and *Carcharodon*, from the Lower Chalk, Portsdown Hill; *Pectunculus* and *Pinna affinis* from the London clay, Fareham	Samuel B. Rosevear, Fareham, Hants.
Collection of Minerals illustrating the sett of the Uranium Mine, St. Stephens—Gossans, Diorite, Lime and Copper Uranites, Galena, Mispickel, Hornblende, Magnetite, Cobalt, Nickel, Chalcopyrite, &c.	The Uranium Mine Co., per Capt. W. R. Thomas, F.G.S.
A collection of Minerals, including:—Malachite, Cassiterite, Quartz crystals, Pyrites, Auriferous Galena, Cuprite, Wolfram, Native Copper, Chalcocite, Redruthite, Calcites (fine forms), Pseudomorphic Quartz	R. H. Williams, M.R.C.S., Lemon Street.

GIFTS TO THE LIBRARY.

Transactions of Royal Geological Society of Cornwall (Vol. 1.)	The Society.
An Index to the Reports of the Meetings of the British Association from 1831 to 1860	John D. Enys, F.G.S., Enys.
Report of the British Association at Leeds, 1890...	
Catalogue of the Tertiary Mollusca and Echinodermata of New Zealand	
Fishes of New Zealand	
Echinodermata of New Zealand	
Studies in Biology	
Geological Explorations of New Zealand, 1870-1; 1871-2; 1877-8; 1878-9	
An Essay on Ornithology, by Walter Buller	
do. Botany, by William Colenso	
An Address on the Industries of New Zealand ...	
Natural History of New York Zoology (5 vols.) ...	
do. do. Botany (2 vols.) ...	
do. do. Mineralogy (1 vol.)	
do. do. Palæontology (5 vols.)	
do. do. Geology (4 vols.) ...	
do. do. Agriculture (5 vols.)	
U.S. Naval Astronomical Expeditions, vols. 3 & 6...	
Mineral Resources of the United States...	
do. do. West of the Rocky Mountains	
Reports of the Mining Industry in New Zealand ...	Government of New Zealand.
On the Genesis of Binodal Quartic Curves for Conics	H. M. Jeffery, M.A., F.R.S.
U.S. Geol. Survey, Ninth Annual Report, 1887-8 ...	The Government of the United States of America.
do. 1888	
do. Bulletins, 58-61, 62-4, and 66 ...	
do. Monograph, Lake Bonneville ...	
Smithsonian Report	
do. U.S. Natural History Museum	
Two Account Books of the Coinage Hall, Truro ...	W. J. Clyma, Truro.
Framed Portrait of the late J. Jope Rogers, M.P., President of the Institution, 1867-69	Capt. Rogers, R.A., Penrose, Helston.

Report of the Museum of Owens College	The Curator, Owens College.
Journal of the Marine Biological Association, Vol. I (N.S.)	The Association, Plymouth.
Official List of Members of the 7th International Congress of Hygiene	Dr. Rundle.
Phaon and Sappho, a play, with a selection of Poems by J. D. Hosken, Helston	The Rev. S. Rundle, M.A., Godolphin.
List of Abandoned Mines, corrected to December 31st, 1890	Prof. C. Le Neve Foster, D.Sc., B.A.
Summaries of the Statistical portion of the Reports of H.M. Inspectors of Mines	
Progress of the Art of Mining, Introductory Lecture to the Mining Students of the Royal College of Science, by Prof. Foster, D.Sc. ..	The Author.
Time Reckoning for the Twentieth Century	Sanford Fleming, LL.D., Washington.
Collection of Ancient Marbles at Leeds, by E. L. Hicks	Leeds Philosophical & Literary Society.
Reprints of three Editorials on the Toxic effect of matter accompanying the tubercle Bacillus and its nidus	Bacteriological Laboratory, Acad. of Sciences, Philadelphia.
Hazell's Annual, 1891	Hazell, Watson, and Viney, Ltd., London.
Portrait of the Right Hon. Lord St. Levan, President of the Institution, 1871-73	The Rt. Hon. Lord St. Levan.
Carved Oak, belonging to the former Mayor's chair which stood in St. Mary's Church. This oak is to be used in the making of a Presidential chair for the Institution	J. Claude Daubuz, High Sheriff of Cornwall.
The Wealth and Progress of New South Wales, 1889-90	Agent General of New South Wales.
Year book of New South Wales	
Two old Maps, (1) the S.W. Counties of England and Wales; (2) Cornwall, 1630	Thurstan C. Peter, Redruth.
Thesaurus Ecclesiasticus Provincialis, or a Survey of the Diocese of Exeter, 1782	
Framed Portrait of Mr. Edwin Dunkin, F.R.S., F.R.A.S., President of the Institution, 1889-91	The President.
"The Midnight Sky," new edition, by Edwin Dunkin, F.R.S.	By the Author.
Archivos do Museu Nacional do Rio-de-Janeiro, Vol. VII	The Government of Brazil.
Le Muséum National de Janeiro et son influence sur les Sciences Naturelles au Brésil	

BOOKS PURCHASED.

Nature.
Zoologist.
Science Gossip.
Knowledge.
Ray Society.
Palæontographical Society.
Meteorological Magazine.
British Rainfall.
Journal of the Royal Microscopical Society.
The Western Antiquary.
The Life of Sir Humphry Davy.
Agricultural Geology, by Nicholas Whitley, Truro.
The Eagle, Vol. I.
Transactions of the Royal Geological Society of Cornwall, Vol. IV.

EXCHANGES WITH OTHER SOCIETIES.

Academy of Natural Sciences of Philadelphia ...	Philadelphia.
Anthropological Institute of Great Britain and Ireland	London.
Bath Natural History and Antiquarian Field Club	Bath.
Belfast Naturalists' Field Club	Belfast.
Berwickshire Naturalists' Club	Cockburnspath.
Birmingham Natural History and Microscopical Society	Birmingham.
Birmingham Philosophical Society	Birmingham.
Boston Society of Natural History	Boston, U.S.A.
Bristol and Gloucester Archæological Society ...	Gloucester.
Bristol Naturalists' Society	Bristol.
British and American Archæological Society of Rome	Rome.
Canadian Institute	Toronto.
Colorado Scientific Society...	Denver, Colorado, U.S A.
Cumberland and Westmoreland Association for the Advancement of Literature and Science	Carlisle.
Department of Mines	Sydney, New South Wales.
Der K. Leop-Carol Deutschen Academie du Naturforscher	Halle.
Devonshire Association	Tiverton.
Eastbourne Natural History Society	Eastbourne.
Elisha Mitchell Scientific Society	Chapel Hill, U.S.A.

Essex Field Club	Buckhurst Hill.
Geologists' Association	London.
Geological Society of Edinburgh	Edinburgh.
Geological Society of Glasgow	Glasgow.
Geological Society of London	London.
Greenwich Royal Observatory	Greenwich.
Leeds Philosophical and Literary Society	Leeds.
Le Museu Nacional do Rio-de-Janeiro	Rio-de-Janeiro.
Liverpool Literary and Philosophical Society ...	Liverpool.
Liverpool Engineering Society	Liverpool.
Liverpool Naturalists' Field Club	Liverpool.
Liverpool Polytechnic Society	Liverpool.
London and Middlesex Archæological Society ...	London.
Manchester Geological Society	Manchester.
Meriden Scientific Association	Meriden, Conn., U.S.A.
Mining Association and Institute of Cornwall ...	Camborne.
Mineralogical Society of Great Britain	London.
Missouri Botanical Garden	Missouri, U.S.A.
Natural History Society of Glasgow	Glasgow.
New York Academy of Sciences	New York.
North of England Institute of Mining and Mechanical Engineers	Newcastle-upon-Tyne.
Nova Scotian Institute of Natural Science	Halifax, Nova Scotia.
Patent Office	London.
Penzance Natural History and Antiquarian Society	Penzance.
Philosophical Society of Glasgow	Glasgow.
Plymouth Institution	Plymouth.
Powys-land Club	Welshpool.
Quekett Microscopical Club	London.
Rochester Academy of Science	Rochester, New York.
Royal Astronomical Society	London.
Royal Cornwall Polytechnic Society	Falmouth.
Royal Dublin Society	Dublin.
Royal Geological Society of Cornwall	Penzance.
Royal Geological Society of Ireland...	Dublin.
Royal Historical and Archæological Society of Ireland	Dublin.
Royal Institution of Great Britain	London.
Royal Irish Academy	Dublin.
Royal Physical Society of Edinburgh	Edinburgh.

Royal Society of Edinburgh	Edinburgh.
Seismological Society of Japan	Yokohama.
Smithsonian Institution	Washington.
Society of Antiquaries of London	London.
Society of Arts	London.
Société Mineralogique de France	Paris.
Somersetshire Archæological and Natural History Society	Taunton.
The Colliery Engineer	Scranton, U.S.A.
The Antiquary	Malton.
Wagner Free Institute of Science	Philadelphia.
Y Cymmrodorion Society	London.
Yorkshire Geological and Polytechnic Society ...	Halifax.
Zoological Society of London	London.

The following papers were then read :

"An Ancient Settlement on Trewortha Marsh."—Rev. S. Baring Gould, M.A.

"A Tin Hebrew Image found in Bodwen Moor."—Rev. W. Iago, B.A.

"Cornubiana."—Rev. S. Rundle, M.A.

"Magnetic Rocks of Cornwall."—Mr. T. Clark.

The Rev. W. Iago described the Hammer used formerly by the Duchy to mark blocks of tin; gave a new reading of the St. Hilary Stone; shewed rubbings and casts illustrating the inscriptions on other stones in Cornwall :—viz., those at Liskeard Castle, South-hill, Boslow, St. Hilary, St. Clements, Cardinham, Endellion, Carnsew (Hayle), Sancreed, Minster, &c., several of which had not hitherto been deciphered; and shewed the interesting Chalice and Paten from Kea, of French workmanship, lent by Mr. Daubuz.

"Colour Changes in Cornish Stoats."—Mr. H. Crowther, F.R.M.S.

"Oyster Spat on a pipe bowl."—Mr. E. Rundle, F.R.C.S.I.

A very handsome volume, the History of the Hundred of Blackheath, Kent, was presented to the Society by Dr. H. H. Drake, formerly of St. Austell, but now resident in London. It is a large folio volume, richly illustrated, and showing great research and much painstaking,—the presentatation was made through Mr. Silvanus Trevail.

The proceedings terminated with votes of thanks to the Officers of the Society, the readers and contributors of papers, the Chairman, and the Secretary.

Dr. Mr. Arthur C. Willyams, Hon. Treas., in account with the Royal Institution of Cornwall. Cr.

Date	Dr.	£	s.	d.	Date	Cr.	£	s.	d.
1890. July 31st.	To Balance brought forward	52	9	8	1891. July 31st.	By Curator	56	0	0
1891. July 31st.	„ Interest on Deposit Notes	30	8	3		„ Fire Insurance	2	14	0
	„ H.R.H. Prince of Wales	20	0	0		„ Nature	1	7	0
	„ Subscriptions	132	14	0		„ Palæontographical Society	1	1	0
	„ Robert Harvey	10	10	0		„ Repairs to Building	7	1	7
	„ Visitors' Fees	7	19	6		„ Ray Society	1	1	0
	„ Sale, &c., of Journals	14	3	8		„ Zoologist	0	12	0
	„ Excursion	13	19	0		„ Taxes	1	10	0
						„ Rainfall, &c.	0	10	0
						„ Excursion	13	0	1
						„ Museum Expenses	37	1	0
						„ Printing (Journal 36), &c.	133	0	2
						„ Sundries	26	10	3
						Balance	0	16	0
		£282	4	1			£282	4	1
	Balance	0	16	0					

TABLE No. 1.

Summary of Meteorological Observations at Truro, in Lat. 50° 17′ *N., Long.* 5° 4 *W., for the year* 1891, *from Registers kept at the Royal Institution of Cornwall.*

1891.	MONTHLY MEANS OF THE BAROMETER. Cistern 43 feet above mean sea level.																	
Month.	Mean pressure corrected to 32 deg. Fahr. at sea level. 9 a.m.	3 p.m.	9 p.m.	Mean of monthly means.	Mean correction for diurnal range.	True mean of monthly means.	Mean force of vapour.	Mean pressure of dry air.	Corrected absolute maximum observed.	Day.	Corrected absolute minimum observed.	Day.	Extreme range for the month.	Mean diurnal range.	Greatest range from 9 a.m. to 9 p.m.	Day.	Greatest range in any 24 consecutive hours.	Between which days it occurred.
	ins.	ins.	ins.	ins.	in.	ins.	in.	ins.	ins.		ins.		ins.	in.	in.		in.	
January	30·202	30·194	30·194	30·197	·004	30·193	·219	29·974	30·738	14	29·653	24	1·085	·090	·36	7	·75	29 & 30
February	30·449	30·438	30·366	30·421	·003	30·418	·216	30·220	30·726	2	29·820	26	0·906	·060	·16	24	·31	27 & 28
March ...	29·849	29·843	29·874	29·855	·007	29·848	·210	29·559	30·540	3	29·176	10	1·364	·070	·28	9	·50	9 & 10
April	29·929	29·930	29·936	29·932	·004	29·928	·261	29·672	30·393	16	29·450	3	0·943	·067	·17	13	·25	13 & 14
May	29·763	29·768	29·779	29·770	·003	29·767	·281	29·495	30·264	12	29·343	18	0·921	·100	·29	7	·57	7 & 8
June	29·986	29·983	29·997	29·989	·001	29·988	·403	29·582	30·441	12	29·660	4	0·781	·046	·14	4	·26	11 & 12
July	29·953	29·958	29·961	29·957	·002	29·955	·388	29·566	30·193	13	29·756	29	0·437	·060	·13	14	·20	15 & 16
August ...	29·827	29·832	29·825	29·828	·004	29·824	·406	29·415	30·139	7	29·424	27	0·715	·070	·21	27	·39	27 & 28
September	30·005	30·006	30·007	30·006	·004	30·002	·414	29·591	30·331	16	29·591	1	0·740	·064	·19	15	·25	1 & 2
October ...	29·646	29·642	29·693	29·660	·006	29·654	·359	29·340	30·338	29	29·100	21	1·238	·100	·31	4	·51	23 & 24
November	29·833	29·833	29·813	29·826	·004	29·822	·242	29·579	30·570	5	29·027	14	1·543	·112	·32	13	·64	11 & 12
December	29·993	29·990	29·995	29·993	·003	29·990	·259	29·972	30·588	20	29·408	10	1·180	·105	·41	13	·68	13 & 14
Means ...	29·969	29·968	29·970	29·969	·004	29·965	·304	29·664	30·438		29·450		0·988	·079	·25		·44	

REMARKS.—The Barometer used is a Standard, made by Barrow, and compared with the Standard Barometer at the Royal Observatory, Greenwich, by Mr. Glashier. The corrections for Index Error +0·008), Capillarity (+0·013), height above sea (43 feet), and temperature, have been applied.

TABLE No. 2.

1891. MONTHLY MEANS OF THE THERMOMETER.

Month.	9 a.m. Dry Bulb.	9 a.m. Wet Bulb.	3 p.m. Dry Bulb.	3 p.m. Wet Bulb.	9 p.m. Dry Bulb.	9 p.m. Wet Bulb.	Mason's Hygrometer. Mean of Dry Bulb.	Mean correction for diurnal range.	True mean of Dry Bulb.	Mean of Wet Bulb.	Mean correction for diurnal range.	Mean temp. of evaporation.	Wet Therm. below dry.	Mean dew point.	Dew point below Dry Therm.	Self Registering. Mean of all the Maxima.	Mean of all the Minima.	Approximate mean temp.	Correction for the month.	Adopted mean temp.	Daily mean range.	Absolute. Maximum.	Day.	Minimum.	Day.	Range.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°	°	°	°	°					
January	43·6	40·2	46·0	41·9	42·7	39·1	44·1	0·4	43·7	40·3	0·3	40·0	3·7	35·6	8·5	46·5	33·6	40·0	0·1	39·9	12·9	55	28	15	8	40
February	47·4	42·1	50·1	44·5	46·5	41·2	48·2	0·7	47·5	42·5	0·5	42·0	5·5	36·3	11·9	54·3	34·9	44·6	0·1	44·5	19·4	65	28	24	10	41
March ...	45·1	40·6	47·6	42·5	44·0	42·6	45·6	1·0	44·6	40·9	0·6	40·3	4·3	35·3	10·3	50·2	36·0	43·1	0·2	42·9	14·2	63	1	28	15	35
April	50·7	45·5	53·5	47·9	50·6	45·8	51·6	1·6	50·0	46·4	1·3	45·1	4·9	41·1	10·4	56·4	39·4	47·9	0·1	47·8	17·0	64	30	31	18	33
May	55·6	48·6	57·9	51·0	55·0	48·5	56·1	2·3	53·8	49·3	1·4	47·9	5·9	43·0	13·1	61·6	42·8	52·2	0·8	51·4	18·8	73	12	30	19	43
June	63·9	57·1	67·4	60·2	63·9	57·6	65·1	2·9	62·2	58·3	1·7	56·6	5·6	52·8	12·2	69·1	51·6	60·3	0·3	60·0	17·5	82	21	39	1	43
July	65·0	57·4	67·0	59·2	64·1	57·0	65·3	2·1	63·2	57·8	1·2	56·6	6·6	51·2	13·4	68·6	52·7	60·6	0·3	60·3	15·9	79	15	40	13	39
August ...	62·8	57·3	65·0	59·1	62·0	56·9	63·3	2·0	61·3	57·7	1·2	56·5	4·8	53·0	10·2	65·3	52·0	58·6	0·3	58·3	13·3	74	16	37	28	37
September	62·8	57·2	65·7	60·0	62·5	57·2	63·1	1·7	61·4	58·1	0·9	57·2	4·2	53·5	11·0	67·2	51·2	59·2	0·2	59·0	16·0	83	13	41	30	42
October...	56·7	51·9	57·1	53·0	55·6	50·2	56·2	0·8	55·4	51·5	0·6	50·9	4·5	47·0	9·0	59·0	43·6	51·3	0·4	50·9	15·4	66	1	35	18	31
November	47·5	43·0	50·2	45·8	47·0	42·6	48·2	0·6	47·6	43·8	0·5	43·3	4·3	38·9	9·9	51·7	39·3	45·5	0·1	45·4	12·1	58	19	26	25	32
December	49·8	45·4	51·6	47·2	48·1	43·7	49·8	0·2	49·6	45·4	0·3	45·1	4·5	40·7	9·1	51·3	39·9	45·6	0·2	45·4	11·4	57	5	27	25	30
Means ...	54·2	48·8	56·6	51·0	53·7	48·5	54·8	1·4	53·4	49·4	0·9	48·5	4·9	44·1	10·7	58·4	43·1	50·7	0·3	50·4	15·3	68		31		37

The Thermometers are placed on the leaded roof of the Royal Institution in a wooden shed, through which the air passes freely. The Standard Wet and Dry Bulbs are by Negretti and Zambra, and have been corrected by Mr Glaisher.

TABLE No. 3.

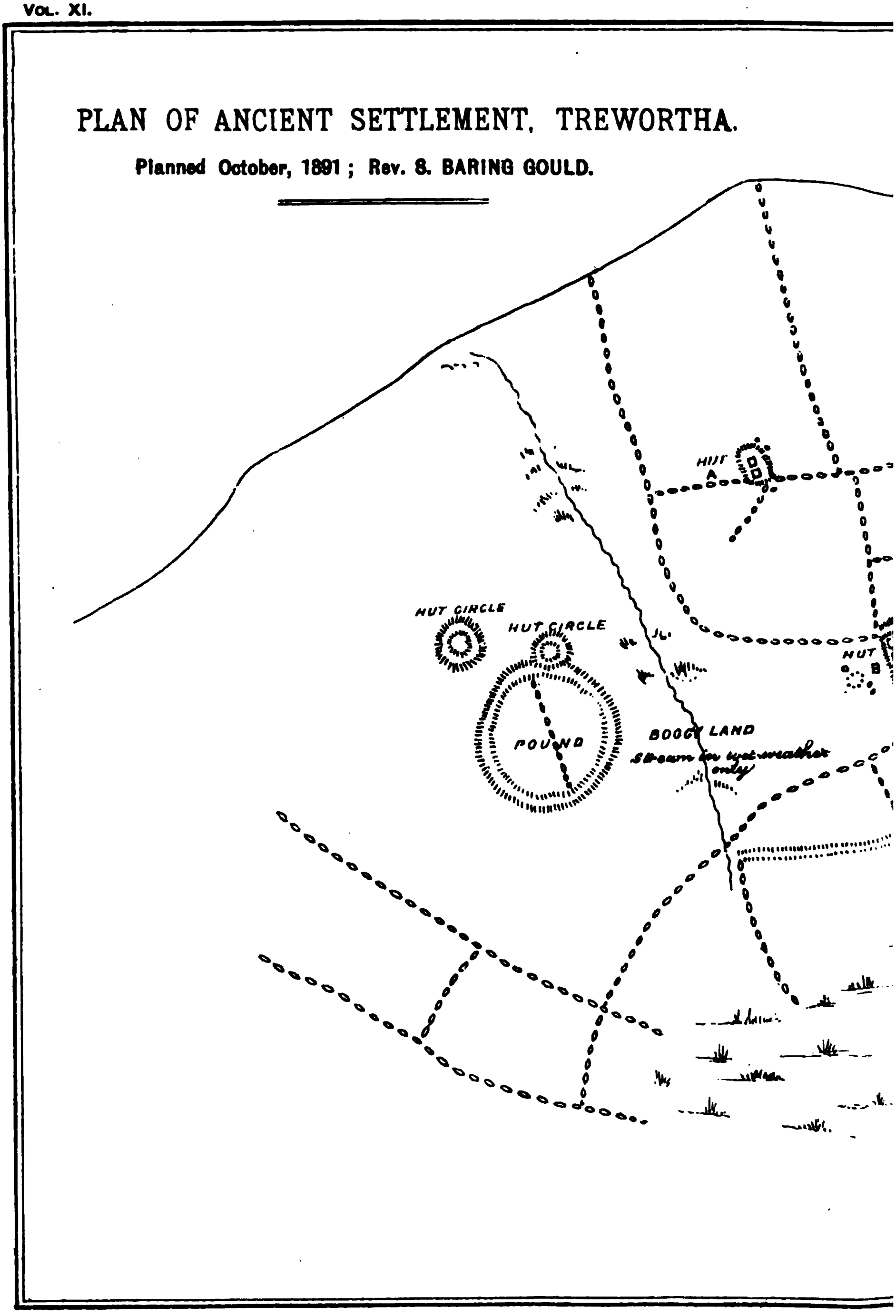
1891.	WINDS.																												
	E.			S.E.			S.			S.W.			W.			N.W.			N.			N.E.			AVERAGE FORCE.			
Month.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	Mean.
January	1	2	2	2	1	0	4	1	4	7	9	8	4	4	3	3	3	3	7	6	7	3	5	4	1·3	1·2	1·3	1·3
February	0	2	0	10	7	8	7	7	6	2	2	2	1	1	3	1	2	1	7	7	8	0	0	0	1·1	1·0	1·0	1·0
March ...	8	7	8	1	0	1	4	3	2	2	4	4	7	7	6	4	4	4	1	2	2	4	4	4	1·9	1·8	2·0	1·9
April ...	5	5	4	7	6	8	2	1	3	9	11	8	1	1	1	2	3	3	3	2	2	1	1	1	1·7	1·7	1·8	1·7
May ...	0	0	0	0	0	0	3	4	5	8	6	7	2	3	1	9	9	9	7	8	8	1	1	1	2·0	1·9	1·9	1·9
June	0	1	0	3	2	2	10	10	12	8	8	8	2	2	1	4	4	3	1	2	3	2	1	1	1·6	1·5	1·6	1·6
July	5	5	5	0	0	0	1	1	0	6	6	5	4	4	4	1	1	4	12	11	11	2	2	2	1·7	1·7	1·7	1·7
August ...	0	0	0	0	0	0	2	1	1	14	14	14	4	3	5	6	7	8	3	5	2	2	1	1	1·4	1·4	1·5	1·4
September	2	4	3	5	7	7	3	3	1	9	5	6	0	2	4	5	5	3	4	3	5	2	1	1	1·6	1·6	1·6	1·6
October ...	5	4	5	2	1	1	1	2	0	14	15	18	3	1	1	1	3	1	3	1	2	2	4	3	1·6	1·7	1·8	1·7
November	3	5	4	1	1	2	0	0	0	10	10	11	1	2	3	2	5	3	6	4	4	4	2	2	1·3	1·4	1·3	1·3
December	0	0	0	3	4	5	4	1	1	15	17	20	5	5	3	1	1	0	1	1	1	0	0	0	2·0	1·9	2·1	2·0
Total	29	35	31	34	29	34	41	34	35	94	107	111	34	35	35	39	47	42	55	52	55	23	22	20	19·2	18·8	19·6	19·2
Means ...	32·0			32·0			37·0			104·0			35·0			43·0			54·0			22·0			1·6	1·5	1·6	1·6

The force of the Wind is estimated on a scale from 0 to 6, from *calm* to violent *storm*.

TABLE 4.

1891. WEATHER. Month.	Average Cloudiness. 9 a.m.	3 p.m.	9 p.m.	Mean.	Rainfall. Rainfall in inches. Truro.	No. of days in which rain fell.	Greatest fall in 24 hours, Truro. Depth.	Date.	Mean weight of vapour in a cubic foot of air.	Mean additional weight required for saturation of the air.	Mean humidity of atmosphere.	Mean elastic force of vapour.	Sun. Shine.	Gleam.	Cloud.	Dry.	Wet.	Remarks.
					in.		in.		grs.	grs.		in						
January	4·6	5·1	6·0	5·2	3·40	15	1·01	8	2·39	0·7	78	·208	41	7	14	74	19	Fog 2, 3. Snow 17. Hail 24, 29. Remarkable Rain 8. Frost 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20.
February	3·8	3·8	4·5	4·0	·22	5	·10	12	2·48	1·2	67	·214	41	6	9	83	1	Frost 2, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 24, 27, 28. Fog 25.
March ...	6·3	6·3	7·0	6·5	3·90	15	1·00	9	2·39	0·9	71	·206	33	11	18	69	24	Frost 11, 12, 13, 14, 15, 16, 19, 20, 31. Hail 25, 26, 27, Blizzard 9. Snow 9, 10, 12.
April	5·1	4·7	5·6	5·1	2·48	13	·42	1	2·97	1·3	68	·258	43	7	10	72	18	Frost 13. Hail 3. Swallows 20.
May	5·5	5·3	6·6	5·8	2·26	18	·57	7	3·20	1·6	64	·277	46	9	7	77	16	Frost 19. Hail 16.
June	5·7	5·1	6·2	5·7	2·86	14	1·00	1	4·55	2·1	67	·400	34	12	14	78	12	Remarkable Rain 1.
July	6·1	4·7	5·0	5·3	1·62	17	·34	29	4·39	2·4	63	·385	43	9	10	84	9	Thunder 30. Thunder and Lightning 26.
August ...	6·5	6·1	7·0	6·5	6·48	25	1·48	20	4·55	1·7	72	·403	37	10	15	67	26	Remarkable heavy Rain 20.
September	6·1	4·9	5·5	5·5	3·03	16	·49	20	4·55	1·4	79	·410	43	7	10	71	19	Very stormy and wild 18, 19, 20.
October...	6·1	6·0	7·0	6·4	8·55	25	1·93	5	3·69	1·5	70	·323	37	10	15	60	33	Remarkable heavy Rain 5, 13. Thunder 14. Hail 14. Gale 13, 15.
November	6·0	6·0	7·3	6·4	5·03	20	1·19	10	2·76	1·0	73	·237	36	10	14	64	26	Frost 24, 25 26, 27, 29, 30. Remarkable Rain 10. Hail 9, 11, 21. Fog 22, 23, 24. 30.
December	6·1	5·5	7·0	6·2	5·22	25	0·67	27	2·86	1·1	73	·254	37	11	14	60	33	Frost, 1, 12, 17, 21, 22, 23, 24, 25. Hail 11, 13. Fog 22, 23, 24, 25. Thunder and Lightning 11.
Means ...	5·6	5·3	6·2	5·7	45·05	208	0·84		3·39	1·4	70	·297	39·2	·09	12·5	71·5	19·6	

Cloudiness is estimated by dividing the sky into ten parts, and noting how many of these are obscured. The rain gauge at Truro is placed on the flat roof of the Royal Institution, at about 40 feet from the ground. Gleam is recorded when the sun's disk is visible through a film of cloud.


PLAN OF ANCIENT SETTLEMENT, TREWORTHA.
Planned October, 1891; Rev. S. BARING GOULD.
HUT A
HUT CIRCLE
HUT CIRCLE
POUND
BOGGY LAND
Stream in wet weather only
HUT B

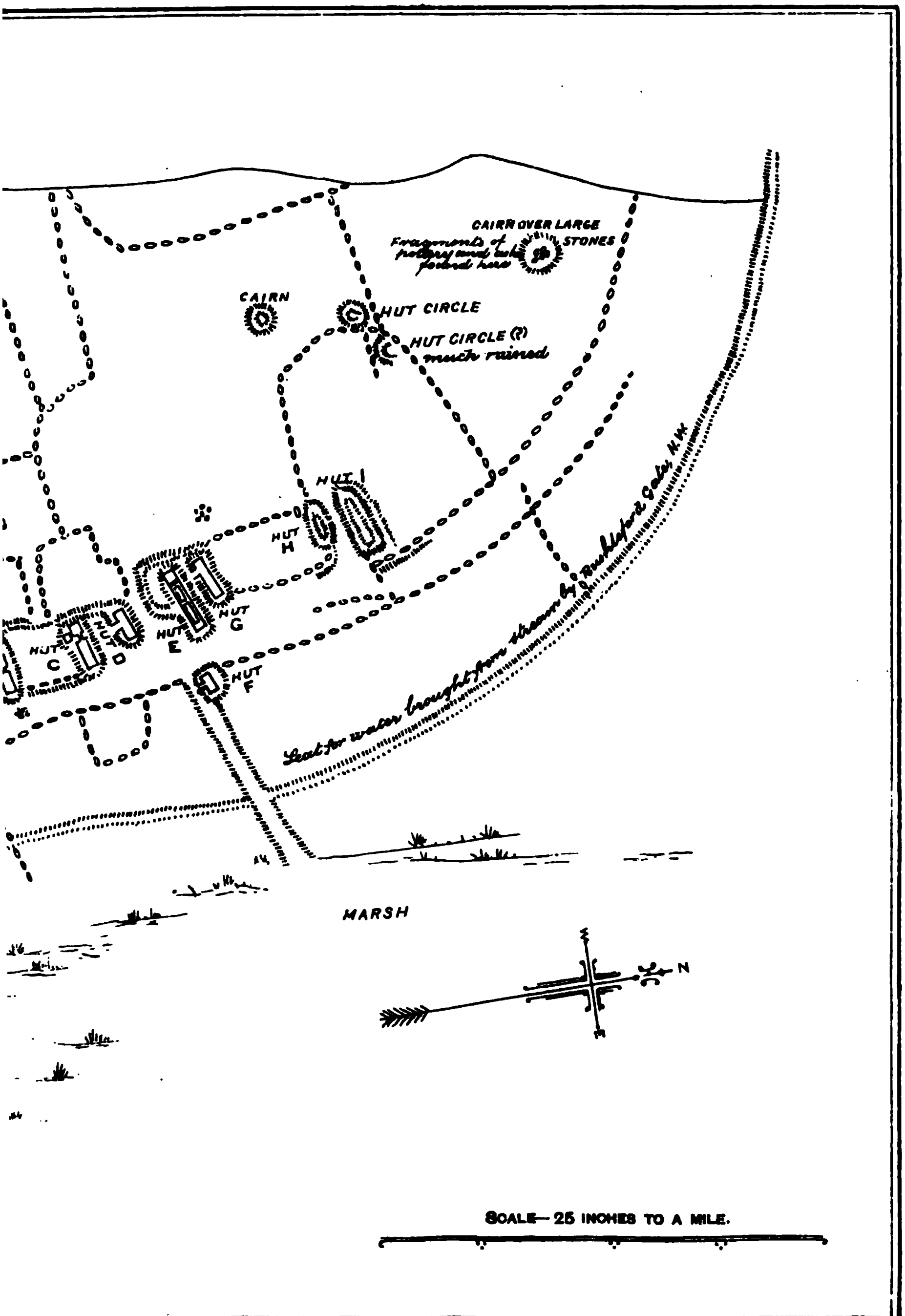

CAIRN OVER LARGE STONES
Fragments of pottery and ashes found here
CAIRN
HUT CIRCLE
HUT CIRCLE (?) much ruined
HUT I
HUT H
HUT G
HUT E
HUT D
HUT C
HUT F
Leat for water brought from stream by Rushleford Gate, N.W.
MARSH
N
SCALE—25 INCHES TO A MILE.

TABLE No. 2.

1891. Month.	9 a.m. Dry Bulb.	9 a.m. Wet Bulb.	3 p.m. Dry Bulb.	3 p.m. Wet Bulb.	9 p.m. Dry Bulb.	9 p.m. Wet Bulb.	Mason's Hygrometer. Mean of Dry Bulb.	Mean correction for diurnal range.	True mean of Dry Bulb.	Mean of Wet Bulb.	Mean correction for diurnal range.	Mean temp. of evaporation.	Wet Therm. below dry.	Mean dew point.	Dew point below Dry Therm.	Self Registering. Mean of all the Maxima.	Mean of all the Minima.	Approximate mean temp.	Correction for the month.	Adopted mean temp.	Daily mean range.	Absolute. Maximum.	Day.	Minimum.	Day.	Range.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°		°	°	°	°	°					
January	43·6	40·2	46·0	41·9	42·7	39·1	44·1	0·4	43·7	40·3	0·3	40·0	3·7	35·6	8·5	46·5	33·6	40·0	0·1	39·9	12·9	55	28	15	8	40
February	47·4	42·1	50·1	44·5	46·5	41·2	48·2	0·7	47·5	42·5	0·5	42·0	5·5	36·3	11·9	54·3	34·9	44·6	0·1	44·5	19·4	65	28	24	10	41
March ...	45·1	40·6	47·6	42·5	44·0	42·6	45·6	1·0	44·6	40·9	0·6	40·3	4·3	35·3	10·3	50·2	36·0	43·1	0·2	42·9	14·2	63	1	28	15	35
April	50·7	45·5	53·5	47·9	50·6	45·8	51·6	1·6	50·0	46·4	1·3	45·1	4·9	41·1	10·4	56·4	39·4	47·9	0·1	47·8	17·0	64	30	31	18	33
May	55·6	48·6	57·9	51·0	55·0	48·5	56·1	2·3	53·8	49·3	1·4	47·9	5·9	43·0	13·1	61·6	42·8	52·2	0·8	51·4	18·8	73	12	30	19	43
June	63·9	57·1	67·4	60·2	63·9	57·6	65·1	2·9	62·2	58·3	1·7	56·6	5·6	52·8	12·2	69·1	51·6	60·3	0·3	60·0	17·5	82	21	39	1	43
July	65·0	57·4	67·0	59·2	64·1	57·0	65·3	2·1	63·2	57·8	1·2	56·6	6·6	51·9	13·4	68·6	52·7	60·6	0·3	60·3	15·9	79	15	40	13	39
August ...	62·8	57·3	65·0	59·1	62·0	56·9	63·3	2·0	61·3	57·7	1·2	56·5	4·8	53·0	10·2	65·3	52·0	58·6	0·3	58·3	13·3	74	16	37	28	37
September	62·8	57·2	65·7	60·0	62·5	57·2	63·1	1·7	61·4	58·1	0·9	57·2	4·2	53·5	11·0	67·2	51·2	59·2	0·2	59·0	16·0	83	13	41	30	42
October...	56·7	51·9	57·1	53·0	55·6	50·2	56·2	0·8	55·4	51·5	0·6	50·9	4·5	47·0	9·0	59·0	43·6	51·3	0·4	50·9	15·4	66	1	35	18	31
November	47·5	43·0	50·2	45·8	47·0	42·6	48·2	0·6	47·6	43·8	0·5	43·3	4·3	38·9	9·9	51·7	39·3	45·5	0·1	45·4	12·1	58	19	26	25	32
December	49·8	45·4	51·6	47·2	48·1	43·7	49·8	0·2	49·6	45·4	0·3	45·1	4·5	40·7	9·1	51·3	39·9	45·6	0·2	45·4	11·4	57	5	27	25	30
Means ...	54·2	48·8	56·6	51·0	53·7	48·5	54·8	1·4	53·4	49·4	0·9	48·5	4·9	44·1	10·7	58·4	43·1	50·7	0·3	50·4	15·3	68		31		37

The Thermometers are placed on the leaded roof of the Royal Institution in a wooden shed, through which the air passes freely. The Standard Wet and Dry Bulbs are by Negretti and Zambra, and have been corrected by Mr Glaisher.

TABLE No. 3.

1891.	WINDS.																											
	E.			S.E.			S.			S.W.			W.			N.W.			N.			N.E.			AVERAGE FORCE.			
Month.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	Mean.
January	1	2	2	2	1	0	4	1	4	7	9	8	4	4	3	3	3	3	7	6	7	3	5	4	1·3	1·2	1·3	1·3
February	0	2	0	10	7	8	7	7	6	2	2	2	1	1	3	1	2	1	7	7	8	0	0	0	1·1	1·0	1·0	1·0
March ...	8	7	8	1	0	1	4	3	2	2	4	4	7	7	6	4	4	4	1	2	2	4	4	4	1·9	1·8	2·0	1·9
April ...	5	5	4	7	6	8	2	1	3	9	11	8	1	1	1	2	3	3	3	2	2	1	1	1	1·7	1·7	1·8	1·7
May ...	0	0	0	0	0	0	3	4	5	8	6	7	2	3	1	9	9	9	7	8	8	1	1	1	2·0	1·9	1·9	1·9
June	0	1	0	3	2	2	10	10	12	8	8	8	2	2	1	4	4	3	1	2	3	2	1	1	1·6	1·5	1·6	1·6
July	5	5	5	0	0	0	1	1	0	6	6	5	4	4	4	1	1	4	12	11	11	2	2	2	1·7	1·7	1·7	1·7
August ...	0	0	0	0	0	0	2	1	1	14	14	14	4	3	5	6	7	8	3	5	2	2	1	1	1·4	1·4	1·5	1·4
September	2	4	3	5	7	7	3	3	1	9	5	6	0	2	4	5	5	3	4	3	5	2	1	1	1·6	1·6	1·6	1·6
October ...	5	4	5	2	1	1	1	2	0	14	15	18	3	1	1	1	3	1	3	1	2	2	4	3	1·6	1·7	1·8	1·7
November	3	5	4	1	1	2	0	0	0	10	10	11	1	2	3	2	5	3	6	4	4	4	2	2	1·3	1·4	1·3	1·3
December	0	0	0	3	4	5	4	1	1	15	17	20	5	5	3	1	1	0	1	1	1	0	0	0	2·0	1·9	2·1	2·0
Total.. ...	29	35	31	34	29	34	41	34	35	94	107	111	34	35	35	39	47	42	55	52	55	23	22	20	19·2	18·8	19·6	19·2
Means ...	32·0			32·0			37·0			104·0			35·0			43·0			54·0			22·0			1·6	1·5	1·6	1·6

The force of the Wind is estimated on a scale from 0 to 6, from *calm* to violent *storm*.

The name Trewortha means in Cornish, the upper settlement, and it may have been given to that cluster of oblong habitations now under consideration. Tresillan, the other settlement, is, perhaps, Tre-sulien, that of one named Sulien.

The cluster of oblong houses lies on the slope facing east, in a tongue of land formed by Smallacombe Down between the Withy-brook from the south, and a stream from Goodaver Downs that flows into Trewortha Marsh from the west. To the east is a dip in the moor, between Trewortha Tor and Ridge, through which the distant chain of Dartmoor Tors from Sourton to Mistor can be seen. The space occupied by the settlement is 500 feet by 300 feet, and consists of nine rectangular huts,—ten, if we include one on a mound in the marsh, and there are some two or three hut-circles as well.

Of these oblong huts all point east and west, and have their doors to the south. A peculiar feature is that they have a high bank thrown up to the west, above them, to give shelter against wind and rain, and in some cases there is a passage between this shelter bank and the head of the house.

Another peculiar feature is the approach to this colony from the north by Rushleford-gate. It is along a broad road, sixty feet across, enclosed within track lines of upright stones, but on approaching the settlement the road is partly blocked by a line of upright large stones drawn across it, having in the midst a gateway ten feet wide. At the south end of the village, the road again contracts to 30 ft., and there are some large stones in the middle that may have belonged to a cross-wall. They are not earth-fast, and have at one time been upright.

We will now take each hut by itself; and begin with one that lies apart from the rest, it is marked A on the plan. This has not as yet been completely excavated. It consists of two chambers that never communicated with each other. That to the east is lined throughout with upright slabs of stones, and measures 7-ft. 6-in. by 6-ft. 3-in. The doorway, exceptionally, faces the east. One of the jambs alone is *in situ*; the other lies outside, as does also the lintel. The western-most chamber, 9-ft. by 7-ft. 6-in., has the walls built for the most part in rude courses, but two upright slabs have been utilised. The door is to the

south, and is not constructed of uprights. About 8 feet to the south, is a large upright stone, 3 feet high. There are traces of boundary stones round the mass that represent the walls, but whether originally set on edge as about a cairn, or that they are merely stones fallen from the walls, has not been decided as yet by the spade.

Hut B. The interior length of this hut is 50-ft. It contains three compartments, all entered from that in the centre, which alone has a door for egress. This central chamber has not been excavated. It measures 12-ft. 6-in. by 10-ft. 6-in. The doorway is not in the middle. Both jambs are standing, they are stones 3-ft. high, and the lintel is just without, a slab measuring 4-ft. by 2-ft. 3-in. The opening between the jambs is 2-ft. 6-in.

Turning to the right is a door in the party wall leading into the largest apartment, measuring 24-ft. long, by about 10-ft. wide. The jambs remain in place. This chamber seems to have been lined with upright slabs of granite. It has not yet been excavated.

Turning from the vestibule to the left, a doorway of which one of the jambs is gone, gives admission to a small chamber, measuring 9-ft. 6-in. by 12-ft. The walls of this house are 3-ft. thick, but the western wall is four times the width of the east, and the object for this width was to allow of the construction in its thickness of both an oven and a locker, each to the depth of 5-ft. The oven was never of "cloam," but was constructed of granite, and precisely like a beehive hut in structure. It was 3-ft. in diameter, built of granite-stones gathered together so as to overlap and form a dome. Fires have turned the stones red, and have so injured them that the top of the oven has fallen in. The bottom of the oven was but 6 inches above the level of the floor. Close to the oven, in the depth of the wall is a locker, the opening to which is 1-ft. 4-in. wide, and 1-ft. 7-in. high, running five feet into the depth of the wall, and covered over with four or five slabs of granite. It was no doubt placed close to the oven that its contents might be kept dry; those in the furthest depth could only be extracted by means of a crooked stick. We removed the coverers, but found nothing in the locker, and then

TABLE 4.

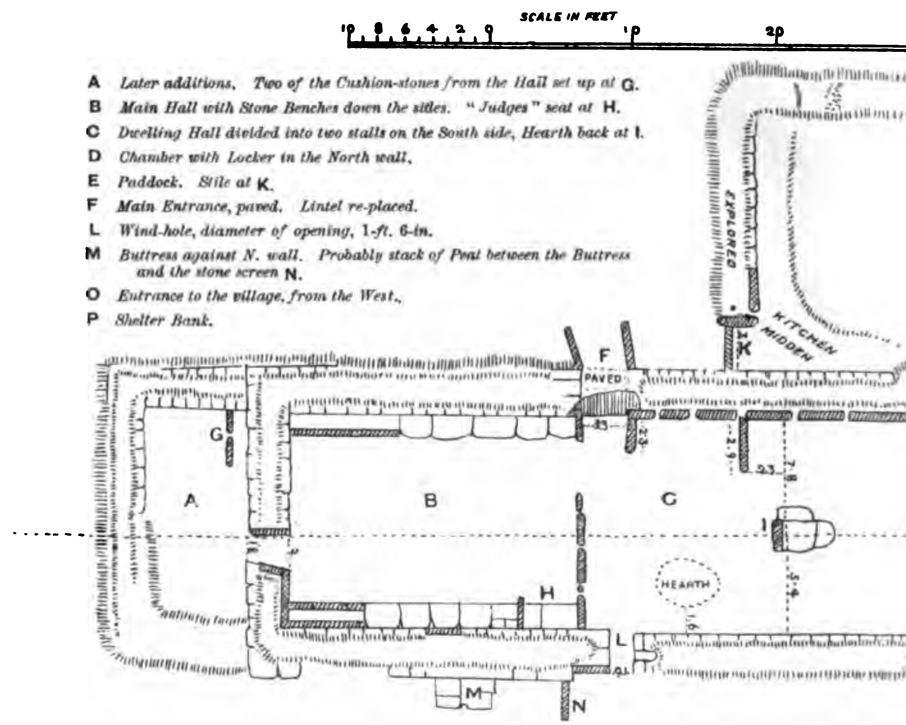
1891.	WEATHER.																	
Month.	AVERAGE CLOUDINESS.				RAINFALL. Rainfall in inches.		RAINFALL. Greatest fall in 24 hours, Truro.		Mean weight of vapour in a cubic foot of air.	Mean additional weight required for saturation of the air.	Mean humidity of atmosphere.	Mean elastic force of vapour.	SUN.			Dry.	Wet.	REMARKS.
	9 a.m.	3 p.m.	9 p.m.	Mean.	Truro.	No. of days in which rain fell.	Depth.	Date.					Shine.	Gleam.	Cloud.			
					in.		in.		grs.	grs.		in						
January	4·6	5·1	6·0	5·2	3·40	15	1·01	8	2·39	0·7	78	·208	41	7	14	74	19	Fog 2, 3. Snow 17. Hail 24, 29. Remarkable Rain 8. Frost 1, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, 18, 19, 20.
February	3·8	3·8	4·5	4·0	·22	5	·10	12	2·48	1·2	67	·214	41	6	9	83	1	Frost 2, 10, 11, 13, 14, 15, 16, 17, 18. 19, 20, 24, 27, 28. Fog 25.
March ...	6·3	6·3	7·0	6·5	3·90	15	1·00	9	2·39	0·9	71	·206	33	11	18	69	24	Frost 11, 12, 13, 14, 15, 16, 19, 20. 31. Hail 25, 26, 27. Blizzard 9. Snow 9, 10, 12.
April	5·1	4·7	5·6	5·1	2·48	13	·42	1	2·97	1·3	68	·258	43	7	10	72	18	Frost 13. Hail 3. Swallows 20.
May	5·5	5·3	6·6	5·8	2·26	18	·57	7	3·20	1·6	64	·277	46	9	7	77	16	Frost 19. Hail 16.
June	5·7	5·1	6·2	5·7	2·86	14	1·00	1	4·55	2·1	67	·400	34	12	14	78	12	Remarkable Rain 1.
July	6·1	4·7	5·0	5·3	1·62	17	·34	29	4·39	2·4	63	·385	43	9	10	84	9	Thunder 20. Thunder and Lightning 26.
August ...	6·5	6·1	7·0	6·5	6·48	25	1·48	20	4·55	1·7	72	·403	37	10	15	67	26	Remarkable heavy Rain 20.
September	6·1	4·9	5·5	5·5	3·03	16	·49	20	4·55	1·4	79	·410	43	7	10	71	19	Very stormy and wild 18, 19, 20.
October...	6·1	6·0	7·0	6·4	8·55	25	1·93	5	3·69	1·5	70	·323	37	10	15	60	33	Remarkable heavy Rain 5, 13. Thunder 14. Hail 14. Gale 13, 15.
November	6·0	6·0	7·3	6·4	5·03	20	1·19	10	2·76	1·0	73	·237	36	10	14	64	26	Frost 24, 25 26, 27, 29, 30. Remarkable Rain 10. Hail 9, 11, 21. Fog 22, 23, 24. 30.
December	6·1	5·5	7·0	6·2	5·22	25	0·67	27	2·86	1·1	73	·254	37	11	14	60	33	Frost, 1, 12, 17, 21, 22, 23, 24, 25. Hail 11, 13. Fog 22, 23, 24, 25. Thunder and Lightning 11.
Means ...	5·6	5·3	6·2	5·7	45·05	208	0·84		3·39	1·4	70	·297	39·2	·09	12·5	71·5	19·6	

Cloudiness is estimated by dividing the sky into ten parts, and noting how many of these are obscured. The rain gauge at Truro is placed on the flat roof of the Royal Institution, at about 40 feet from the ground. Gleam is recorded when the sun's disk is visible through a film of cloud.

PLAN OF PRINCIPAL HOUSE, TR

Planned October, 1891 ; Rev. S. BARING GOU

- **A** *Later additions. Two of the Cushion-stones from the Hall set up at* G.
- **B** *Main Hall with Stone Benches down the sides. "Judges" seat at* H.
- **C** *Dwelling Hall divided into two stalls on the South side, Hearth back at* I.
- **D** *Chamber with Locker in the North wall.*
- **E** *Paddock. Stile at* K.
- **F** *Main Entrance, paved. Lintel re-placed.*
- **L** *Wind-hole, diameter of opening, 1-ft. 6-in.*
- **M** *Buttress against N. wall. Probably stack of Peat between the Buttress and the stone screen* N.
- **O** *Entrance to the village, from the West.*
- **P** *Shelter Bank.*



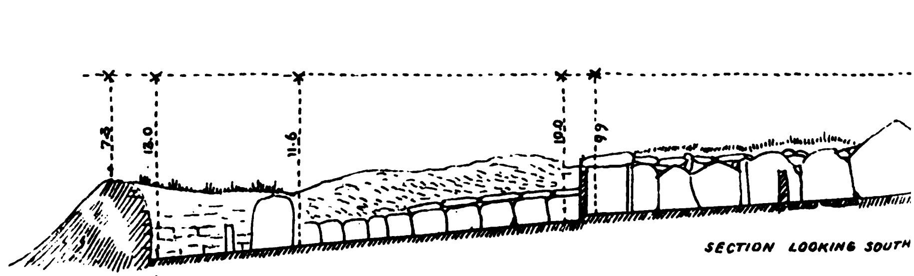
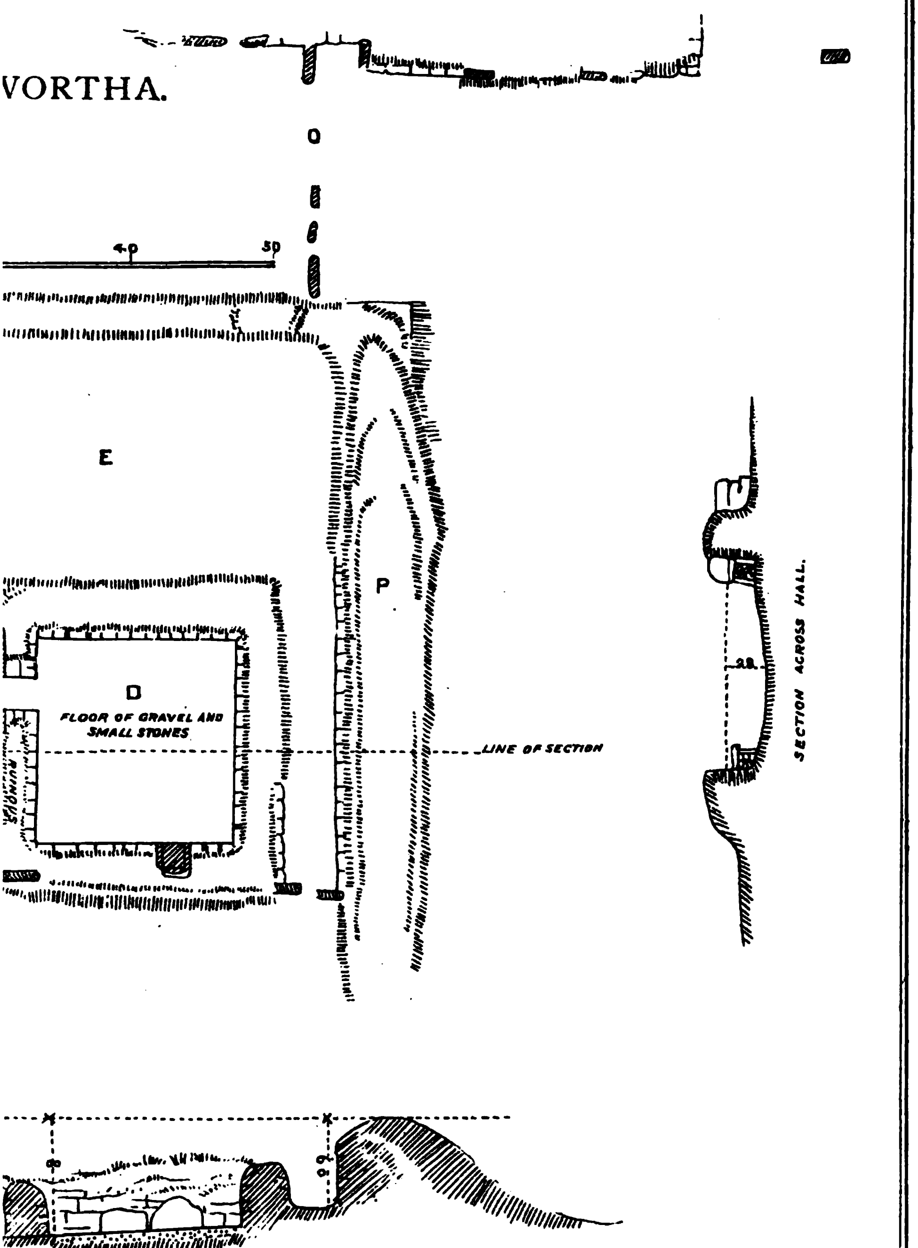


PLATE II.

VORTHA.

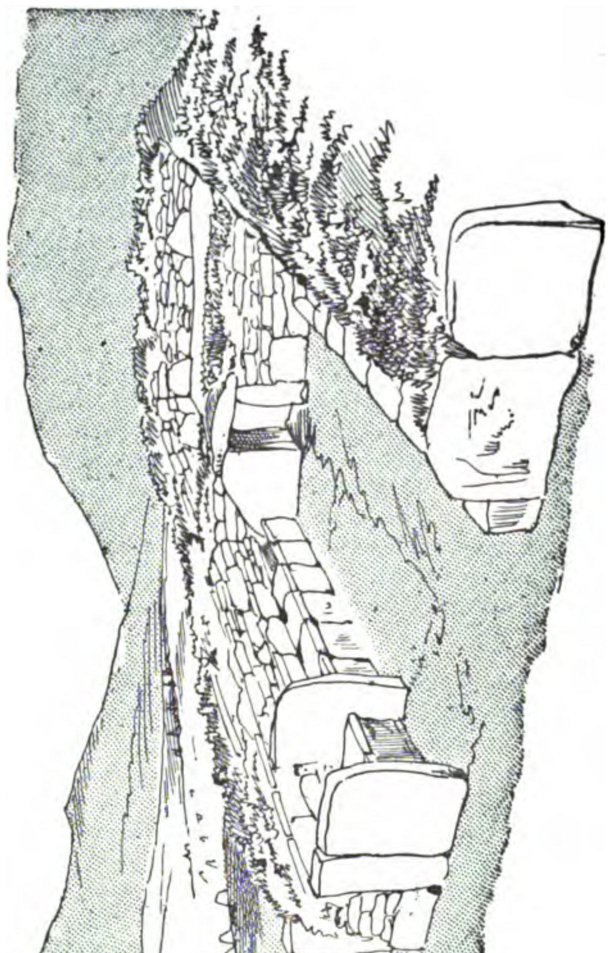


another similar screen of granite, standing out 2-ft. 9-in. from the wall and dividing off a portion of the hall that is 12-ft. 9-in. long. Not only so, but in the midst of the hall is an upright slab of granite, 2-ft. 3-in. high, with a paved hearth to the west of it which, as well as this slab, bears tokens of fire. This, then, was the fire-hearth and fire-back for the dwellers in the upper compartment of the hall. Those in the lower had also their hearth, but it was on the unpaved floor, and it was without a fire-back. The soil was burnt brick-red where it had stood. Apparently two families had occupied this hall, their sleeping portions separated by a stone screen, and each had its own fire. This is very much the arrangement of an Esquimo house at the present day. The south wall is entirely composed of upright slabs of granite. The wall on the opposite side is in a ruinons condition, and never had a range of upright stones to constitute or to line it.

Passing through a narrow door, 2-ft. wide, partly of stones set upright as jambs, and partly of stones in courses, we reach a small chamber measuring 13-ft. 4-in. by 14-ft., the floor of which was very hard, and made of granite sand, and pebble, beaten down into a sort of compost with clay. In the north wall of this apartment is a stone locker, the floor of which is 15 inches above the floor of the chamber. It is 18 inches high and as many deep. It is covered by two slabs of granite, still in place. In this easternmost chamber were found some fragments of pottery.

If we return to the dwelling-hall, where were the two fires, we find a curious feature in the north wall, opposite the entrance. This is a narrow opening, 1-ft. 6-in. in diameter, on the floor-level. Of its original height there are no means of judging, outside this is a granite screen, 3-ft. 3-in., at right angles to the wall, and rising to the same height from the ground. This is to the east of the opening. The similar screens outside the main doorway are to the east and west of that door. The only possible explanation of this hole with its screen is, that it was a draught-opening in the wall, either for clearing the house of smoke, or for helping the fires to draw. Possibly, when the fires would not burn with the wind in one quarter, the opening in the wall was

employed to create a suitable current of air. If now we turn to the right at the great entrance, we find ourselves in a hall 20-ft. long, with a row of benches of stone down each side, and on the north side the uppermost seat has granite arms. The seats



PERSPECTIVE VIEW OF THE "COUNCIL HALL" LOOKING N.E., THE SCREEN REMOVED TO SHOW THE SEATS ON N. SIDE.

(By kind permission of the "Daily Graphic.")

are formed of upright slabs, eighteen inches high, erected so that their faces shall run parallel with the side-walls, 1-ft. 8-in.

from them. On the north side there is a double such line, one being erected against the wall. The space between is filled in with small pieces of granite and sand, wedged together very compactly, and then a slab of granite with a straight edge was placed on this shelf thus constructed. The only seat that is different in construction is that with the elbows. It is built up of stones and turf, and has no face of stone to support the cushion stones. This elbowed-seat is four feet between the elbows. The side to the west is formed of two upright slabs, that to the east of one alone. The elbows rise 1-ft. 4-in. above the seat. There are two cushion-stones to this seat, which would very well accommodate two persons. The rest of the bench would hold about 8 persons, and ten persons might sit on the opposite side. The cushion-stones are very distinct, and seem to have had a straight edge put to them. They are not all in place, but some dozen are. The seats on the south side are at a slightly lower level than those on the north side. No fire seems ever to have been kindled in this hall; we could discover no trace of fire on the floor. Close to the entrance was found a granite handquern, the internal concave portion polished with friction. At the lower end of this hall with benches is a doorway communicating with the easternmost chamber. This doorway did not exist originally, and has been knocked through the end wall diagonally. It could not be driven straight through owing to a large stone that formerly formed part of the foundation of the outside wall. Moreover, the junction of more recent structure is observable outside, the walls returning at right angles, and not being dovetailed into those in the same line of this easternmost apartment. In this room or linney that measures 7-ft. by 14-ft., were two of the cushion stones that had been removed from the seats in the hall, and set up on their sides in the ground, to form what appeared to have been a manger for yearlings, but which had no stone to close the end. These slabs were so slightly sunk in the floor, that they fell when exposed, and we replaced them on the seats in the hall, where they fit exactly.

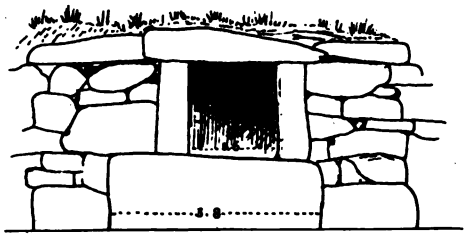
The floor of the long hall, between the rows of benches, is very much sunk in the middle. Possibly sheep or bullocks may have been driven through it to this chamber at the end, and have worn the depression. It is, however, difficult to understand

how a bullock could have been got through the door at the east end, for it is only 2-ft. wide, and if we may judge from the jambs found in place, it cannot have been above 2-ft. 6-in. high.

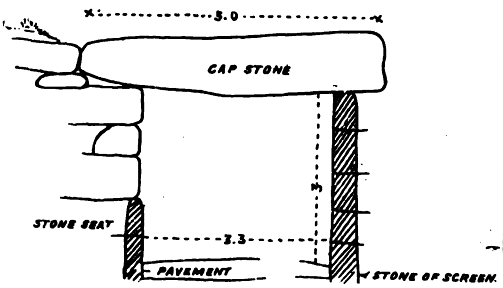
The "Council Hall" may, however, have been utilized in later times for bullocks, and the cushion-stones removed to make mangers for the cattle. If this were so, then perhaps the traces of a central hearth were destroyed.

To return to the hall of seats. The stone-slabs that formed a screen between it and the upper hall, where were the hearths were five in number. Two formed the elbow to the upper seat on the north side. In a line with this, were three more. All were lying on their faces down hill, but of their position there could be no doubt, as the groove in the soil remained, showing where they had been sunk into the floor. The floor of the room above is a few inches higher than that of the lower hall. Outside this lower hall, on the north side, is a sort of buttress built against the wall, consisting of large stones laid one on the other. I think it not improbable that the supply of peat for fuel in the house was stacked between this buttress and the stone screen already referred to, near the narrow opening in the north wall, into the upper hall. It is possible, were this the case, that the fuel was thrown in through this hole. The north side would be that least exposed to driving rain, and it would have been a convenience to thrust the fuel in on the same side as the stack, instead of having to carry it all round the house. Outside the opening, west of the stone-screen, were slabs of stone, either pavement, or lintels of the opening that had been cast down.

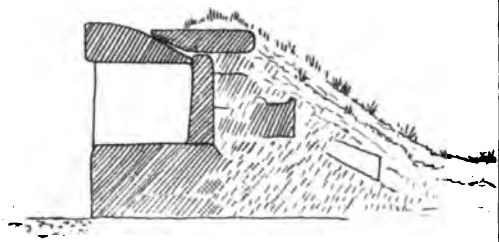
To return to the main entrance on the south side. West of the screen that sheltered the door, at the distance of 6-ft. 6-in., is a stone stile into the little paddock that adjoins the house on the south. It is 3-ft. wide, and the stile slab is 2-ft. 5-in. above the ground. It is held in place by a stone jamb, a slab standing 3-ft. 6-in. from the ground, and 2-ft. 6-in. wide. On the west side of this stile we found the kitchen midden of the house, a stratum of peat-ashes and broken crockery lying on the virgin soil, about an inch thick. Here we found three broken hones, a slate spindle-whorl, two flint chips, and a broken polished flint celt-head. I may add that we found two more hones in the hall with the benches.



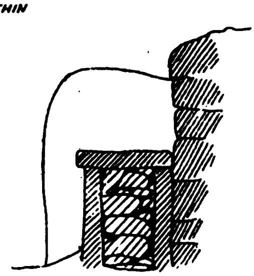
ELEVATION OF LOCKER IN CHAMBER D.



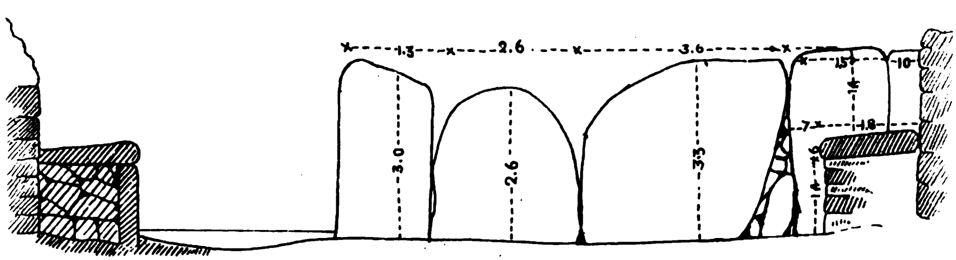
ELEVATION OF DOOR FROM WITHIN



SECTION OF LOCKER, CHAMBER D.



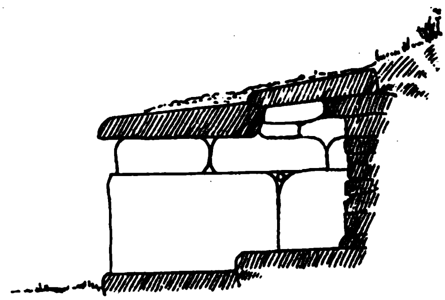
SECTION OF SEAT, N. SIDE, BELOW "JUDGE'S" CHAIR.



ELEVATION OF SCREEN AND SECTION OF SEATS

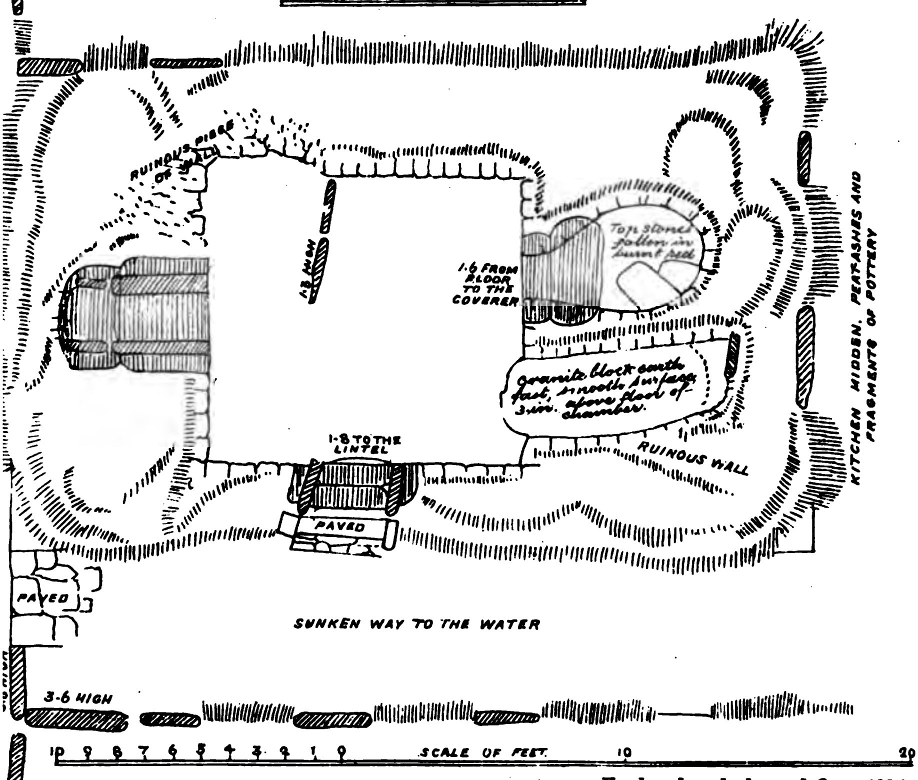
ELEVATION OF EAST WALL, SHOWING OVEN AND BED (?)

ELEVATION OF LOCKER IN N. WALL.



SECTION OF LOCKER, S. SIDE, IN W. WALL.

12 INCHES 0 1 FEET. 2 3 4



PLAN OF HUT E

Explored and planned Oct., 1891.

REV. S. BARING-GOULD.

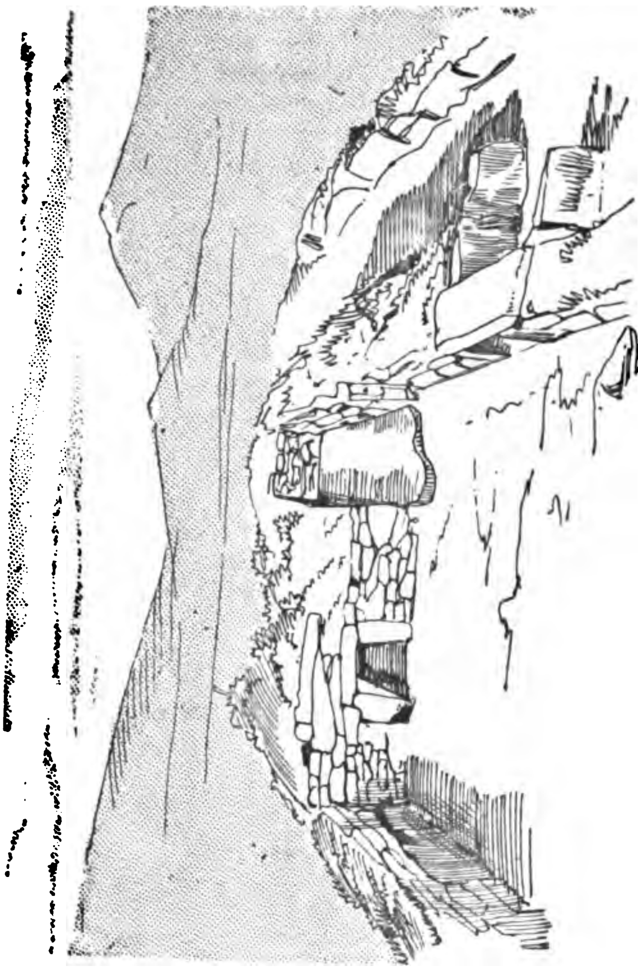
On the west end of this house is a passage between its wall and the shelter-bank. This bank slopes down to the moor surface rapidly on the west, but was walled towards the east. The passage is 3-ft. 3-in. wide, and was provided at the north end with granite jambs, to serve as doorway. The lintel, if there was one, is gone.

We come now to Hut F. This has been pretty thoroughly explored. It consists of a single chamber, measuring 11-ft. by 10-ft. It lies to the east of the other habitations, and has the peculiarity of possessing enormously thick walls to the east and west, seven and ten feet in diameter. On the south was a paved entrance from what may be called the village green, that led to a sunken way continued about 250-ft. to the marsh, protected on each side by a wall of upright stones. After entering this sunken way, a door opens on the left, 10-ft. down; it is somewhat askew, and the floor is paved. The jambs are 2-ft. 6-in. apart, and rise but 1-ft. 8-in. from the threshold stones. The lintel is 4-ft. 6-in. long. It was lying with the jambs, fallen, but we have set them up. The door is unusually low, and the hut must have been entered not crawling on all fours—that would be impossible, but wriggling in sideways. In the western wall which is 7-ft. thick is a locker, the floor of which is but a couple or three inches above the floor of the chamber. The locker is four feet deep, and is in two stages, rising a step half way in. The height is 2-ft. 3-in. at the mouth. It has two granite coverers *in situ*, never displaced.

The wall to the north of this locker is very ruinous, as is also a portion of that at right angles to it. In the floor were two stones set up on their edge, rising about 1-ft. 3-in. above the floor, and enclosing a portion of the area, very much in the same manner as in the Hebrides to this day, in some of the turf and stone hovels, curbstones are set up in the floor to serve as seats by day, and to form the bounds of a bed at night.

The east wall contains an oven built in the same fashion as that in Hut B. The floor is level with the floor of the hut. The dome has been burnt and has crumbled in. There can be no question as to the purpose of this construction, the stones reveal the action of fire. Close to the oven, separated from it by a narrow wall, is a singular long hole, running 7-ft. 6-in. into the depth of

the wall. It has as its floor a huge earthfast granite block with smooth upper surface, rising 3 inches above the level of the chamber-floor, and extending nearly, not quite, to the extremity of the locker. This locker differs from the others, in that it is



PERSPECTIVE VIEW OF HUT F, LOOKING EAST.
(By kind permission of the "Daily Graphic.")

2-ft. 9-in. wide at the entrance, and it apparently widens in the middle to 3-ft., but the wall on the south side is in too ruinous

a condition for an exact measure to be taken. Was this a bed recess! or was it a warm store place near the oven?

The kitchen midden to this hut was found at the east end; where were much peat-ash and many fragments of pottery, at a depth of about 3-ft. 6-in. from the present surface.

Hut G has been but partially explored. On the north side is a structure like a goose or goat house, but very small, and in this fragments of pottery were found. Large upright slabs of stone have been employed in places to form the walls. There seems to have been no division into chambers. The door was near the west end in the south wall, and has its jambs. Whether there was another door further down, or whether a fallen upright slab has formed a gap in the wall, can not be determined without further spade work.

Hut H consists of a single chamber. It has not as yet been searched. Nor has Hut I, that consists of two chambers. A remarkable feature of Hut I is that a trench was carried round the head and north side to convey away any water that ran down the hill-slope towards it.

There are further structures deserving examination and notice. One of these is a circle of stones to the south of Hut B. There are, showing, about 16 stones, and all seem at one time to have been upright. Whether they were ranged in two concentric rings, and formed the base of a hut-circle is not certain. The diameter is 12 feet.

Another circle is very much more distinctly a habitation. The hearth-stones show above the moss. This will have to be explored. Near it is what is probably another hut-circle, but so defaced and pillaged for stones, that its character has been almost destroyed.

To the south of the settlement is a large circle about 100-ft. in diameter, a pound, with a division running down the centre from east to west, and adjoining it are the remains of two hut-circles. East of the settlement and north-east, are two cairns of small stones, apparently burnt. One, the larger, was constructed over five huge fallen stones, that I at first supposed to be a ruined cromlech. But pick and spade showed that the bases of these stones had never been moved by man. Among the stones and

peat that covered them were found fragments of pottery similar in kind to that strewn in the kitchen middens of the settlement.

Numerous barrows or cairns spot the surface of the hill-shoulders all round Trewortha. We have explored but one systematically. It contained a kistvaen, which was empty. Beneath the kistvaen was a slab of stone embedded under a layer of clay. Under the slab was the virgin soil, locally called "the country," in which a hollow had been scooped, and there some ashes were laid. No pottery, no flint, nor bronze were found.

If we come now to the question as to the date of this settlement, the question remains unsolved. The presence of hones shews that iron was in use. The pottery is wheel-turned. The discovery of flint proves nothing. A small fragment of iron, apparently of an iron pot, has a much more recent look than pre-historic times.

It would be rash to speculate as to the date of these remains till some further evidence has turned up for fixing it. So far not a particle of glass, not a coin, not a scrap of anything but the coarsest local pottery have been found, the latter wheel-turned indeed, but badly burnt; and composed of clay with granite-sand in it. Of ornament there is very little. If we may judge from the fragments of the mouths of the vessels, they had very wide mouths, some 14 inches in diameter, and all were of bulging shape. No glazing exists on any of them. What we do learn from the remains is that they were inhabited by people who lived very much the lives of Eskimo. Here is Dr. Nansen's account of an Eskimo house :—"In winter they live in regular houses built of stone and turf, and with the floor generally below the surface of the ground. These houses or huts contain but one room, which serves as the abode of the whole family, or generally of an aggregation of families, men and women, young and old, being more or less promiscuously mixed up together. The room is of an oblong shape, and is commonly so low that it is all but impossible to stand upright in it. Along the whole back wall goes the principal bench, which was 5-ft. to 6-ft. deep. On this sleep the whole family, or rather the married members and the unmarried daughters, lying side by side, with their feet towards the back, and their heads pointing into the room

....If there are several families in occupation of the same house, which is the rule, the main bench is divided by low partition-boards into separate stalls for each family." "Each of the families," he says elsewhere, "had its own partition marked off from the common couch, and in each stall so formed, man, wife, and children would be closely packed, a four-foot space thus having to accommodate husband, two wives, and six or more children," (F. Nansen, "Across Greenland," 1890).

We have in the largest hut precisely this arrangement,—it is divided into two stalls for two families, each with its own hearth.

The houses must have been low, roofed with rafters brought together in the middle, and covered with thatching of rushes and turf. The smoke escaped through the roof. There is not a trace of chimney or of window in any one of the huts.

The upright slabs of granite pretty well mark the height of the walls, they are usually thin and pointed at the top, and could hardly support walling laid above them in courses. Moreover, the fact of the locker and ovens being either on the floor-level or raised but a very few inches above it show that the inmates worked in a crouching position. The doors were generally never higher than 3 feet. I do not lay much stress on the low door in Hut F, as that was fallen, and we may possibly have made some mistake in re-erecting the stones, but other huts have the jambs unfallen.

That the huts were not in continous occupation through a long tract of time I think certain, from the condition of the kitchen middens. Of these we explored two, and both showed no traces of sequence of deposits. Moreover, it was evident that the surface of turf and peaty soil had been removed round the houses, for the layer of ash and pottery lay on that; and there was growth of peat and turf above it to the height of from 2-ft. 6-in. to 3-ft. 6.in.

We found no evidence that the inmates of these huts were engaged in tin mining. No moulds, no dross. On the contrary, there was every appearance that they had been a pastoral people. The hones found were all small, far too small to have served for sharpening sickle or scythe.

But what is the significance of the hall with its benches and its elbow chair at the head? It has the appearance of having been the place of meeting of a Stannary Court. A place of gathering of some solemn character it must have been.

So far the explorations of the ancient settlement on Trewortha has yielded nothing that can fix its date even approximately. But if the fates do not oppose, it is my intention in the spring of 1892 to continue the excavations, in the hope that at length some clearer light may fall on these very remarkable remains, and enable us to determine to what epoch they belong.

I will reserve, till I am able to report on these further researches, what I have to say relative to the tools and pottery found at Trewortha.

With reference to the plan of the settlement, I may add that I have omitted the unfinished cutting and embankment of an abandoned mineral railway that runs to the west. The track lines have been cut through or buried, but can be traced where they emerge west of the bank or cutting. The visitor to the settlement will have no difficulty in finding it. Hut A is just below the last archway in the line.

SKETCH SECTIONS OF TWO SIDES OF A SQUARE PIT NEAR THE BEACH, ON THE NORTH-EAST SIDE OF PENDENNIS HEAD, FALMOUTH.

Examined by Mr. HOWARD FOX, F.G.S., and Mr. NICHOLAS WHITLEY, F.Met.S.
Sept. 18th, 1890.

NOTE BY MR. WHITLEY.

These deposits, recently exposed in an excavation above the base of the cliff, appear to me to call for special examination, as being marked on the Ordnance Geological Map as the site of a "Raised-beach," and so described by Sir Henry De-la-Beche in his report on the Geology of Devon and Cornwall, as a "Raised Beach," p. 428. A detailed consideration of the beds exposed, leads to the conclusion that the mass of the materials have been washed down from the hills above, and not washed up by the sea. The base of the sections, however, does not reach the level of the sea, where it is more than probable that other deposits may be found at a lower level.

The inclined bed of very fine silicious sand is of great interest. The particles are so fine as to form an impalpable powder when touched by the finger. Under the microscope they are all angular and rugged, and of a uniform size, nearly all silicious, except a few plates of mica may be seen, and some black grains of hornblende or schorl. When tested by muriatic acid there is no indication of lime, shells, or coral, so abundant in the harbour sand. On the whole, I am of opinion that the whole mass exposed in the section must be described as the "*Head*," so named by the late Godwin-Austin, and thus described by Dr. James Geike. "The only accumulations in Cornwall which can be recognised as pertaining to the Ice Age, are certain raised-beaches, and the peculiar earthy and stony debris ("head") which caps them. These as we have seen, belong probably to the last inter-glacial epoch and the final cold stage of the glacial period."—*Prehistoric Europe*, p. 437.

Note by Mr. H. Fox.

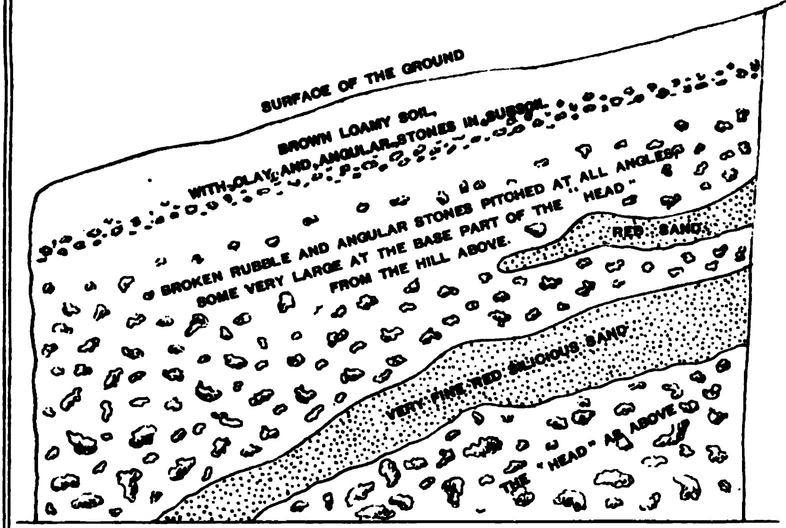
When the Sub-marine Mining Corps were excavating a a pit south of the Falmouth Docks property, in which to build the foundations of their test-house, last autumn, I asked my late much valued friend, Mr. Whitley, to inspect it. He did so, and subsequently sent me the enclosed sketches and description, inviting me to add any further observations. As this was probably his last geological excursion, this paper possesses a peculiar interest and value, and brings to my family and myself the remembrance of a delightful visit, in which his poetical and literary lore illumined the drier geological questions under discussion.

In comparing Mr. Whitley's excellent sketch and notes with those made by myself, I find that the bands of sand appeared to me to have straighter outlines than those given in his drawing, and amongst the "Head" of rubble I observed in addition to bands of clay a good deal of finely crushed rock, free from any admixture of soil.

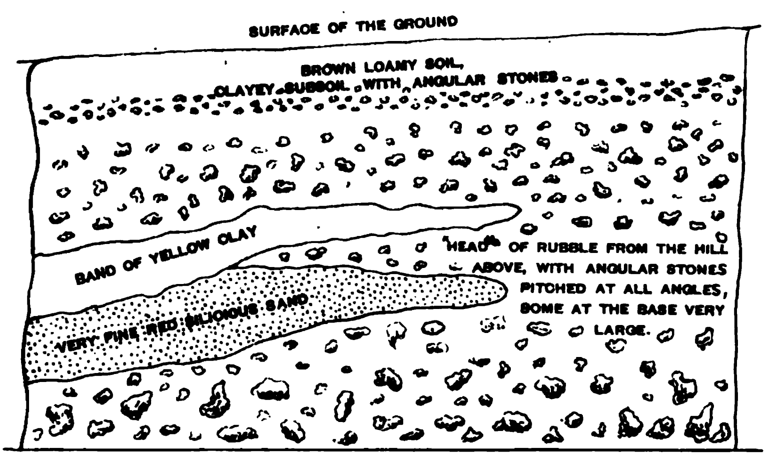
A somewhat similar exposure of sand may now be studied in the excavation behind No. 1 store at the Falmouth Docks.

SKETCH SECTIONS

Exposed in a newly-excavated square Pit near the base of the cliff on the N.E. side of Pendennis-head, Falmouth Harbour.



No. 1. Section of the North side of the Pit, about 30 feet long at the base.



No. 2. Section of the South side of the Pit, being about 39 feet long at the base. The pit is square, and the base may be about 12 feet above high water mark.

PRIVATE TRADE ON THE FALMOUTH PACKETS.

BY ARTHUR HAMILTON NORWAY.

In tracing the history of the Falmouth Packets from 1793 to 1815, a period which includes two wars, separated by the short peace of 1802, it is impossible to avoid the observation that the peace divides the story not only chronologically, but also in other ways of more importance. The conduct of the officers and crews of the packets was creditable in almost every instance in the later war, but in the earlier one it was by no means so distinguished. In fact, so far as can be gathered from the meagre records which still exist, the Falmouth men were far from shewing any readiness to risk their lives between the years 1793 and 1802; and by their conduct they gave some colour to certain grave charges which were brought against them.

In the year 1793 a very loose discipline prevailed at Falmouth. It was not a recent growth. On the contrary, there is reason to believe that the officers of the General Post Office, whose duty it was to regulate the service in the public interest, had long been unfit to exercise control. It was an age of corruption in every department of Government, and the Packet Establishment being located in a distant corner of the country, offered opportunities for peculation which were not likely to be overlooked, and which it was most difficult to check. Many of the packets in those days were owned by officials of the Post Office, from messengers and porters up to the Secretary himself, who indeed received tolerably large sums as fees from the commanders upon their appointment, and whenever fresh commissions were issued to them. It is obvious that this practice, which left persons who were pecuniarily interested in the movements of the packets to direct their voyages, was open to very serious objection; and as a matter of fact nobody believed that the officers in question performed their public duties without sometimes modifying them to serve their private interests.

When this state of things existed at head quarters, it was not to be expected that strict views of duty would be found at Falmouth. The captains were subjected to heavy extortions by the agents, who moreover dealt in every kind of naval stores, and compelled the captains to purchase such articles from them. In return for the complaisance of the captains in this respect, the agents relaxed discipline in any way which the captains might desire. If, for instance, it had occurred to any commander that by sailing with a few men short of his muster he could make an increased profit by saving their victualling allowance, the agent would be careful not to observe what was going on. If the captain wished to stay on shore, and send his packet to sea under charge of one of his officers, the agent would accept and forward to London a certificate that he was ill, without asking any questions either as to the nature of the illness or the qualifications of the person appointed to command the packet, who was not infrequently a common seamen. If the captain had received from some Bristol merchant a larger consignment of goods to sell on commission than the packet ought to carry, the agent would still certify that the vessel was in trim when she left Falmouth Harbour, and had nothing on board which could impede her sailing. In smuggling, which was a tolerably common practice on the packets, the agent could be still more useful; and in fact the opportunities which he had of rendering little services to the captains were so numerous, that it can easily be believed that the post of agent at Falmouth was very lucrative and much coveted.

It was inevitable that investigation should come at last. In the year 1785 a Mr. Bell was agent. Perhaps he extorted from the captains more than they could pay, or, which is on the whole more probable, a stricter view of duty was beginning to be held at the General Post Office. In any case, enquiry was made into Mr. Bell's proceedings, and before it was concluded, he shot himself dead.

This tragical event, coupled with the recommendations of a Committee of the House of Commons, which was appointed shortly afterwards, seems to have led to the establishment of many reforms; and in 1793 entirely new arrangements were made at Falmouth. The agent was forbidden to hold shares in

any of the packets, or to deal in naval stores, or to have pecuniary relations of any sort with the commanders. He was forbidden to accept fees from them, and he was made aware that his authority over them having now being disentangled from the mesh of conflicting interests which had strangled it during past years, was to be exerted in future in the public interest alone. Similarly the clerks at the head office were compelled to dispose of any shares in the packets which they might possess, and the healthy principle that no person ought to direct in matters in which he has a pecuniary concern, was established once for all as the rule of the service. Other reforms were initiated, into which it is not now necessary to enter.

Enough has been said to shew that the Packet service at Falmouth had been in a highly unsatisfactory condition for a long time previous to 1793. It is therefore not surprising to find that a certain amount of demoralisation existed, and that the officers as a body had a low standard of duty. The official records at this period are full of caustic references to this laxity, noted down evidently verbatim from observations made by the Postmaster General.* The following, taken at random from among several others, will shew the general tendency. "The Postmaster General cannot but lament when they look at the absentee list of their captains in time of war to see how many reasons they are constantly urging to stay at home, and of how little use they must consider their own presence at sea. There are now twelve packets at sea, and no less than ten of the captains of them ashore." This was in August, 1793, and the twelve packets referred to were all upon the Falmouth station. But sarcastic appeals such as this produced very little effect, for in 1798 the captains appear to have been scarcely fonder of going to sea than in 1793. By this time, however, a keen intelligence was at work in the General Post Office, and in the following year the absenteeism of the captains was cured by the establishment of the system of mulcts, under which a large tax was levied on the profits of the voyage whenever the captain did not sail in person, the proceeds of the tax being carried to a fund for pensioning the widows of captains and masters in the service.

* At this time the ancient practice was still in force, whereby the office of Postmaster General was held jointly by two persons.

Irregularities such as these are serious enough when found in connection with a service so vital to the interests of the country, as was the safe carriage of the foreign mails and despatches in time of war. Indolence and want of zeal were however to be expected among a body of men who perceived that the actions of their superior officers were governed by self interest; and it is not surprising that the Falmouth captains as a body did not at once respond to the changed tone at head-quarters, and exert themselves to promote the reforms conceived in London. One thing might have been expected from them—that they should fight when they could not otherwise save the mails. Let us now see what actually happened.

Between the outbreak of war in February, 1793, and the peace of 1802, thirty-two Falmouth packets were captured by the enemy. I cannot find that any one of them made a good fight before she struck her flag.

I do not of course charge cowardice against the officers of all or any of these packets. Some were captured by squadrons of frigates, which could have blown them out of the water with ease had they dared to resist. Some were lost under circumstances which shew clearly that their officers were not to blame. By far the larger part of them were captured among the West Indian Islands, in seas where French privateers were found in almost countless numbers. In many cases, only the bare circumstance that the ship was captured is recorded; but after every allowance has been made, the broad fact remains that in the nine years mentioned thirty-two packets were lost, and that not one of them made a really gallant resistance.

That there was no serious fighting in any of these cases is not an unwarranted assumption. It was usual whenever a packet distinguished itself in action to distribute rewards among the officers and crew, proportionate to the bravery displayed. These rewards were not granted for a running fight, but for an action fought close alongside, whether successful or unsuccessful. They were granted in only three cases between 1793 and 1802, and in each of those cases for a successful action.

It will perhaps be said that though it was unfortunate that so many packets were captured, no ground has been alleged for

supposing that there was any want of courage or skill on the part of the officers, and that the packets being lightly armed were no match for the enemy's privateers. There is force in this, yet in the three cases mentioned above these lightly armed packets succeeded in beating off privateers of force far superior to their own, and quite equal to that by which other packets were captured.

The fairest means of judging the conduct of these captains, however, will be to count the number of captures in an equal number of years when the war broke out again. Between July, 1803, and July, 1812, I find that ten packets only were captured, and that five of those hauled down their colours after actions which may fairly be described as desperate, and which reflect the greatest credit on those concerned. Ten captures against thirty-two. How is the difference to be explained? The packets were the same, that is they were built in the same place; the officers and crews of many served in both wars. It cannot be supposed that the French privateers were less active in the one war than in the other. The periods chosen for comparison are long enough to allow for chance circumstances favourable or unfavourable to both alike. What then caused the enormous preponderance of losses in the former war? and how did it happen that the men who fought so well in the later war did not fight in the earlier one?

There were persons who professed to be able to answer this question. In the year 1800, the capture of several West India packets in quick succession provoked very strong remonstrances from the merchants of London, and rumours began to be circulated of large profits made by the officers of the packets out of being captured and losing their ships. No specific charge seems to have been made against any individual, but it was freely asserted that the goods which old custom allowed to be carried on the packets, though the law forbade them, were often insured for the homeward as well as the outward passage before the ship left Falmouth. If then all the goods were sold in the West Indies, it would be a possible thing for the crew to remit the purchase money by a subsequent packet, or even by an armed merchant vessel, and to surrender themselves quietly to

the first privateer they met. They ran the risk of spending some years in a French prison; but on the other hand there was a good chance that the privateer wonld put them on shore in their own boat rather than accept the burden of keeping them on board as prisoners. When they once reached England again they were secure from detection. Nobody could contradict them when they affirmed that the privateer had taken away large quantities of goods which they had not succeeded in selling. Their own assertion was the only evidence of what had occurred which it was possible to procure, and there was thus no difficulty in obtaining the full value of the insurance upon goods of which the purchase money was already in their pockets.

This was the charge against the Falmouth captains, one involving so much base dishonesty that it is natural to hesitate before accepting it.

As soon as it reached the ears of the Postmaster General, they directed the Inspector of packets to proceed to Falmouth, and to make strict enquiry as to whether what they called "so black and desperate a fraud" was possible. The Inspector's report states somewhat boldly that he believed it was not. He gave no other reason for his belief than that no Insurance Company would pay the value of its policy in the absence of an affidavit declaring precisely the quantity and quality of the goods on board the packet at the time of the capture,—overlooking it would seem, that the very nature of the charge involved treachery and lying, and that men who could be supposed guilty of those basenesses would not be likely to hesitate at a perfectly safe perjury.

The Postmaster General adopted the Inspector's conclusion, yet it would seem that some doubt remained in their minds, for they used the occasion to enforce a suggestion which they had before propounded, to the effect that Courts of Enquiry, analogous to Courts Martial, should be held at Falmouth to investigate the circumstances thoroughly, whenever a packet was captured. It was the custom at this time to require from the captain of a captured packet a sworn declaration of the circumstances, attested by himself and one or two of his chief officers. Beyond this declaration no enquiry was made. Thus everything

depended on the bare oath of the persons concerned, unsupported by any systematic questioning of the crew.

At the end of 1799, or in the first weeks of 1800, an order was issued prohibiting the private trade upon the West Indian and American packets. The officers and sailors of those packets were forbidden, under pain of dismissal, to carry goods of any kind upon their vessel in future; and an officer was appointed at Falmouth for the express purpose of searching every packet before she sailed, with full authority to turn out any goods which he might find in any part of the ship, to whomsoever they might belong. The Lisbon packets were allowed to continue the trade, on account of the great importance to merchants of free communication with Lisbon at that time.

The question naturally arises, what induced the Government to take this step? Some strong motive must have prompted it, for the system of private trade upon the packets was so ancient that the Secretary of the Post Office admitted that he could not trace its origin, and thought it might be "coeval with the service itself." That it was extremely profitable to the persons engaged in it cannot be doubted. It was sufficient to attract sailors to the Post Office service, where they worked contentedly for wages far inferior to those paid by the customs or the East India Company; for they knew that by their own small ventures of potatoes or any goods for sale at Jamaica or Barbadoes, they could regain much more than they lost in pay. It is true that the trade was contrary to the law. But the statute condemning it was of the reign of Charles II, and had never been enforced. Indeed so recently as in 1798 the private trade had been explicitly sanctioned in new regulations then drawn up for the guidance of the agent at Falmouth; and it was distinctly stated that his only duty in connection with the private trade was to assure himself that the quantity of goods carried was not enough to throw the vessel out of trim or to impede her sailing.

Here then was an ancient and very highly valued privilege, to attack which was to cause certain disaffection among the seamen, and that moreover in time of war, when it was already sufficiently difficult to provide for the regular despatch of the mails. There had been no long growing dissatisfaction with the

system. What was recognized and approved in 1798 was abolished hardly more than a year later, and immediately, as must have been anticipated, difficulties began at Falmouth. The crews of several vessels refused to proceed to sea, many captains reported that they could not obtain sailors unless the trade was restored; the seamen petitioned the Postmaster General for its restoration, pointing out that their wages, if they must rely on them solely, were not sufficient for their maintenance. This was perfectly true, and the sanction of the Government had to be obtained for increasing the wages. It is not possible that these consequences of the abolition of the trade were not forseen. What induced the Government to draw these difficulties down upon itself in the midst of a dangerous and exhausting war? To deprive the Falmouth sailors of their profits from trade was to render them more than half mutinous. What advantage did the Government anticipate which was to compensate them for disaffection spread among the men to whom the mails and despatches in war time were entrusted?

It is clear that the Government had convinced themselves that the retention of the private trade involved more danger than abolishing it. The danger they had in view may of course have been simply that the presence of goods on board the packets rendered them more valuable prizes than if they carried nothing more than the mails. This does not seem however to account very satisfactorily for the suddenness with which the trade was abolished at an inconvenient time. If the Government believed, or suspected, that the system of insuring goods was connected with the frequent loss of packets, the promptness of their action, and the tenacity with which they adhered to it when confronted with great difficulties, need no further explanation.

Some light may be thrown upon the matter by glancing at the circumstances connected with the capture of two packets on the Lisbon station shortly after this time.

The "Earl Gower," Captain Deake, was on her way home from Lisbon in June, 1801, when she encountered the "Telegraphe" privateer cutter of fourteen guns and seventy men, a force considerably superior to his own. Captain Deake however, was not daunted, but made good use of his guns while

endeavouring to escape, and might possibly have got clear off had not fully half his crew refused either to work the vessel or to fight her, and gone below in a body. Their action is scarcely comprehensible on any other ground than that they wished to be captured. Cowardice would have impelled them to do their utmost to escape, but these men refused to work the vessel, which was of course captured, through no fault of Capt. Deake or of his officers.

The second case is that of the "Duke of York," captured on the 18th September, 1803, while on her homeward voyage from Lisbon. The undisputed facts are these. The packet was chased throughout the day by a French privateer of scarcely more than half her size, though more heavily manned. Towards evening the master, who was acting commander at the time, consulted with the surgeon as to the course proper for them to take in view of the fact that the enemy was gaining on them. The surgeon advised surrender, and the master adopted his suggestion. They came to this resolution while the enemy's vessel was still a mile distant from them, and before she had even fired a summoning gun, they hauled their colours down. It was then seven o'clock, and the night was falling rapidly. This circumstance, however, did not suggest to them the chance of escaping under cover of the darkness, it brought to their minds only the possibility that the enemy might not have seen their flag pulled down. To avoid any misapprehension on this subject they sent a boat on board the privateer, and so, without attempting the slightest defence, they gave away their ship.

A committee of enquiry was held at Falmouth, but the captains who composed it put their questions in such a manner as to shield the culprits so far as possible, and finally stultified themselves by finding that all the officers did everything possible to save their ship. This was simply untrue.

The Inspector of Packets thereupon set himself to work to investigate the matter. He traced, so far as possible, the value of the goods which each sailor had on board, what insurances he had effected on the outward voyage, and what on the homeward, and finally what sum he had gained by the capture. One man, he found, admitted that he had made £300 by this event;

the surgeon, who had advised the surrender, had certainly gained £250, but, by a remarkable lapse of memory, he was quite unable to recollect what sum he had received in Lisbon for goods sold there, so that it was impossible to arrive at the full amount of his profit. The steward's mate was richer by £250, one of the seamen by £200, and most of the crew had pocketed substantial sums.

The next step was to ascertain whether any of these men, and especially those who had made large profits on this occasion, had been captured before.

The surgeon, who had been foremost in advising surrender, and who was also (probably) the largest gainer in the affair, had also been captured more frequently than any other of the crew, except three men. He had been taken no less than three times before. How much money he made on those three occasions is not stated. Three of the crew had been equally unfortunate. Four other men had been captured twice before, most of the rest once, and eight of the crew had been on board the "Gower" at the time of the disgraceful circumstance related above.

The captains who composed the court of enquiry are not perhaps to be very severely blamed if they did not choose to draw the legitimate inference from these facts. The influence of local associations was strong upon them, but the Secretary of the Post Office was controlled by no such ties, and the following extracts from his report shew clearly the conclusion which he formed, very reluctantly, and after long investigation:—

"....These papers prove beyond a doubt that His Majesty's packet could not have been captured if the skill and courage of her crew had been properly exerted. Their Lordships even incline to think that the French privateer might have been captured if our vessel had been carried into action with the spirit which characterizes British seamen in general. No resistance was made. It was not even seen what was the force of the privateer. The packet was not even hailed or fired at by the enemy, and a boat was sent off to meet the privateer, and to accelerate a surrender of which the seamen themselves speak as dishonourable and dishonest....Under these circumstances my

Lords the Postmaster General..never will consent that Mr..... the commander, or Mr..... the surgeon, shall again be employed in their service. The utmost their Lordships can do in regard to the other individuals, after confirming their original dismission from the Lisbon station, is to consent, and that they do with hesitation, to their being permitted to serve with any of the commanders who may choose to employ them on the West Indian and American packets."

The point of this last sentence was plain enough. On the West India packets the private trade was already abolished, so that fraud was no longer possible.

The Inspector of Packets stated his opinion in the following terms:—"I cannot help being of opinion that if during the war officers and seamen are permitted to carry out merchandize on commission or otherwise, there is reason to fear that the loss of the packets on the Lisbon station may be very considerable, unless indeed under disinterested or high-spirited commanders."

In the light of these facts it is very difficult to avoid the conclusion that some at least of the thirty-two packets captured between 1793 and 1815 had been given away in the same treacherous manner as the "Duke of York." Of the thirty-two packets captured, twenty-one were taken on the *homeward* voyage.

In conclusion, I would seek to guard myself from appearing to bring this grave charge against the whole body of Falmouth commanders. I know of no evidence in existence which implicates any individual except in the case just described. It is beyond doubt that there were among the commanders men whose reputation was above question, and of whom, if their ships were captured, it would at once be said that they had done all that courage and seamanship could do to save them. I do not think the materials exist for pursuing the enquiry beyond the point to which I have carried it.

I should add, that an officer of the same name as the acting commander of the "Duke of York," distinguished himself greatly in an action during the American war, in which he was severely wounded.

CORNUBIANA No. 1.

By Rev. S. RUNDLE, M.A.

I. Prehistoric Remains.

The first article that I describe is a small oblong piece of bronze, the edges of which have been greatly worn away. The size is ⅞ of an inch long by ½ inch wide. At each end is a hole, one circular, the other irregular in shape. To the first a pin may have been attached, which was fastened through the second. An intricate pattern—perhaps best described as Arabesque—has been engraved on one side. Below the irregular aperture, a flower is clearly visible. This was found in the stream works below Godolphin Bridge. The next (fig. 3) is a stone semi-oval, so to speak, one portion of the circumference being considerably wider than the other. There is a hole in the centre. The article is roughly and rudely fashioned of a grey moor-stone, and was probably used as a sinker in fishing. One field in Pengwedna, on which it was found, is still known as the swan-pool, though now perfectly dry. In this pool it was most likely used. The two following articles (figs. 1 and 2) agree very much in shape, but differ considerably in size. They are both broken in half, the fracture in each case occurring at the middle of the hole driven through each implement. The holes are very artistic in appearance, seemingly formed by some kind of file. They are wide at the mouth and lessen towards the converging point of the hole from the other face. The faces on both sides seem water-worn, and were probably chosen on this account to save the trouble of fashioning. The largest is about 3 inches long, and the other side about 2½. They belong to the species known as stone hammers, of the neolithic age, and are formed of greenstone. These three last were all found at Pengwedna in Godolphin.

Pedestal found at Carminow.

This was met with in the foundations of the old church at Carminow, and is formed of a peculiarly heavy stone, viz:

Fig. 1.

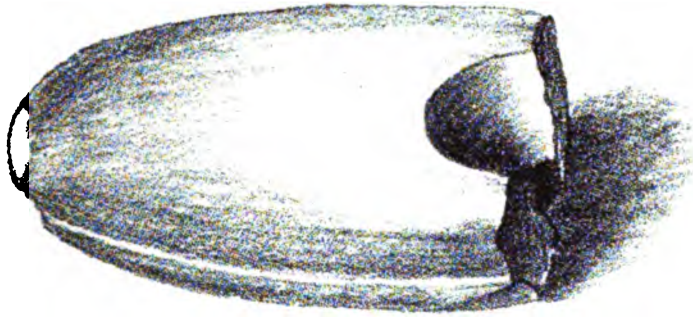
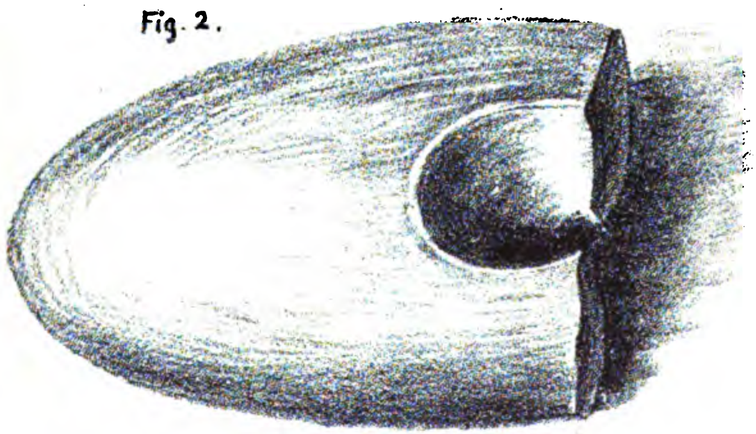


Fig. 2.

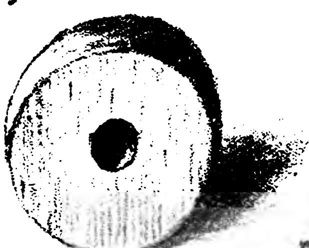


almost real size

W. J. Jeffery

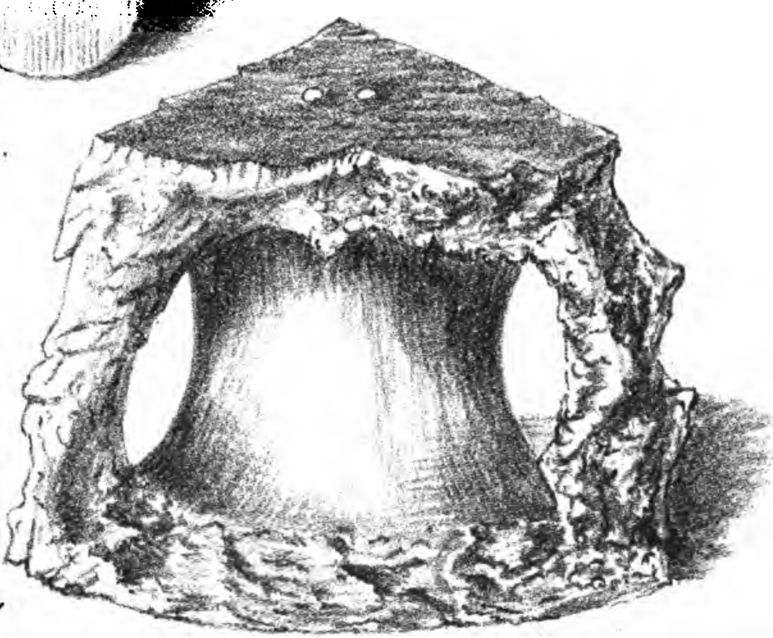
Fig. 3.

Fig. 4.



$\frac{2}{3}$rds real size

Fig. 5.



W. J. Jeffery

sulphate of barium. Its construction is as follows. The shaft bends away from the top to the bottom, being smaller at the top than the bottom. It is perfectly smooth, the obverse being convex, and the reverse concave. Two handles, rudely carved, connect the upper face of the pedestal, which is 3 inches by 2½, forming an irregular triangle with the bottom. The upper portion is perfectly plain, with two holes probably intended for the retention of an image. The foot is hollowed, and is 3½ in. by 2¾ in., for here the pedestal expands. It weighs 10¾ ounces. This was probably the pedestal for an image, and has been stained with some black material. (Fig. 5).

Legends which have taken a Concrete Form.

Legends may be divided into two classes, those that exist merely in oral tradition, and those that apply to some existing memorial as a proof of their truth. It need hardly be said that those of the latter class are quite as devoid of any real basis of fact as the first. I subjoin three instances of legends which have taken a concrete form (1). The St. Breage Churchyard Cross. (2). Dane-wort. (3). The Mill-proo. 1.—St. Breage Churchyard Cross is simply the rounded portion of a cross, from which the shaft has been removed. It stands outside the south porch of the church on a portion of slightly elevated ground. Most of the Cornish crosses are formed of granite: this one is of a kind of yellow sand-stone, and the legend runs that a great battle took place by the barrow of sand near Great Work Mine, between the Cornu-Celts and Saxons, and that so much blood was shed that, when mixed with sand it coagulated into stone, whence the cross was carved to commemorate the event. The material of which the cross is composed certainly corresponds with indurated sand-stone from the above sand-barrow, which is locally known as "Sandy-Burrow." (2). The next legend is that of Dane-wort, Wall-wort, or, as it is more commonly known, dwarf-elder, the scientific name of which is *Ebulus Sambucus*. It seems rare, as but three localities for it are given in Withering's Botany, viz: Tutbury Castle, Staffordshire; Goosegreen, near Dalton, and Tamworth Castle Hill. To these a fourth may be added, the Glebe, St. Erth, where it flourishes in great luxuriance. Tradition relates that close at hand, by the site of the

present bridge, a deadly battle took place between the Danes and the Cornu-Celts. The wounded Danes were carried on litters made of the handles of spears, to the present glebe, and from these spear handles the Dane-wort spring. The third legend of the kind is that of the Mill-proo, which always seems to me to be one of the most extraordinary on record. The Mill-proo (fig. 4) is a dwarf cylinder of stone, pierced throughout by a circular hole, and its origin is said to be this. At certain times of the year, an adder may be found asleep in such a position as to form a complete circle. If a hazel wand of twelve month's growth be placed in the centre of the ring formed by the adder, it is unable to extricate itself. By its hissing, it attracts all the adders in the neighbourhood, which come to the succour of their distressed friend. Slaver is emitted by all of them around the bewitching hazel. As soon as a complete circle is made, the adder is freed. The slaver congeals into stone, and is known as the mill-proo, a fine specimen of which was found some time ago in the stream-works below Godolphin Bridge. It is composed of porcelain stone, is an ounce in weight, an inch in diameter on the flat part, on the cylindrical part $\frac{9}{16}$ long in inches, 3 inches in circumference, and has three small punctures on the flat surface, nearly equi-distant from one another. These, however, may have been the result of accident. In connection with this class of legend I may now allude to another, though of a different cast. Whence the Cornish obtained the legend I know not, unless it be taken as a slight evidence in favour of a Jewish settlement here. The curlews are said to have assisted the Israelites to escape from Pharaoh by going behind them and obliterating their track.

Chronogram.

A Chronogram consists of a sentence in which a date or number is expressed by Roman capitals forming parts of words, which, with this exception, are written in ordinary type. Mr. Hilton, in his standard work on Chronograms (Vol. 1, pp. 27, 29,) quotes two Cornish chronograms, whence they would seem to be rare in this county. A third is given in Tregelles' Cornish Worthies, p. 361, from the pen of Sydney Godolphin. A fourth, and fifth of a peculiarly interesting type, have recently been

found by me. The fifth is on a chalice at St. Ruan Major church, and indicates that the chalice was a votive offering to almighty God for mercies received, and runs as follows—

Votivum Eucharisticum
d.d.d.
in usum Ecclæ Ruan Majoris E. F. 25 Martis 1674.
CLa Ma VI. et Icho Vah aVDIVIt me 1676.
Ergoque Ps CXVI.

By selecting the letters in Roman Capitals, viz: M. D. C. L. V. V. V. V. IIII, we arrive at the date indicated in the ordinary type, viz: 1676. Nothing can be much more touching than the thought of this unknown E. F., more than two hundred years ago, in sad distress, making a vow to Almighty God in 1674, and then two years after, 1676, paying his vows to Him. The inscription is eloquent with distress chequered by hope, which distress at last disappears in the fulfilment of his heart's desire. I am much inclined to think this chronogram, occurring on old Cornish ecclesiastical plate, is unique.

Extracts from Parish Accounts.

Tne first is an extract from the churchwardens' accounts of the parish of St. Martin in Meneage, from Easter, 1776, to Easter, 1777, and contain the amounts paid by the parish for the marriage of a certain Walter Johns. Apparently this Walter Johns had fled to Breage, to escape fulfilling his promise of marriage, there he was arrested—it seems a bad augury for the happiness of his intended marriage that "arrest" was a necessary preliminary to it— he was brought back in triumph by two horses, and was married by "licens" under a salvo of gunpowder, with a banquet of "meat and drink."

	£		
To arresting, marreing Walter Johns .. .. } To three days under arrest .. .. }	1	10	11
To licians (now £2 s2 d6)	1	16	0
To expenses, and Turnpike, fatching them at Breag	0	2	0
To 2 horses	0	2	0
To the Minister for marring them	0	10	6
To the Clerk (now 5 shillings)	0	1	0
To meat, drink and firing to the wedding ..	1	13	0

The following are the expenses of the Easter Meeting, 1792, at St. Anthony in Meneage, as given in the churchwarden's accounts.

1792.

	s.	d.
Expenses at Easter meeting		
One gallon of spirits (prob. rum)	8	0
Lemon	1	0
2 lbs. of sugar, 1/1½ lb.	2	3
At the House..	2	0
	13	3

The same accounts bear testimony to the destruction of foxes, etc.

1783-84.	To cash for an ould fox	2/6
1786.	To two half-grown foxes	4/-
1788.	To 3 polecats.. ..	1/-

Various similar entries are found in the registers of the Meneage parishes: E. 9. *At Gunwalloe are these entries—

Killing 3 Foxes	7s. 6d.
Killing 1 Fox	2s. 6d.

From the foregoing extracts, it seems that half-a-crown was the price fixed on a fox's head.

The Cornish Chough in Heraldry.

The Cornish Chough is by no means confined in Heraldry to Cornish families, though of course it occurs more frequently in their emblazonments than in those of other countries. In these latter, the Cornish chough may be used as an indication of their Cornish descent; by way of difference; or it may be simply a "canting" usage, as is plain from the arms of Cornwallis, Co. Worcester, which were "sable, guttée on a fess argent, three Cornish choughs argent." Sometimes no reason is now assignable

Though the emblem is by no means exclusively Cornish, yet a glance at the armouries of Cornish families will show how

* Cumming's Cury and Gunwalloe, pp. 122-130,

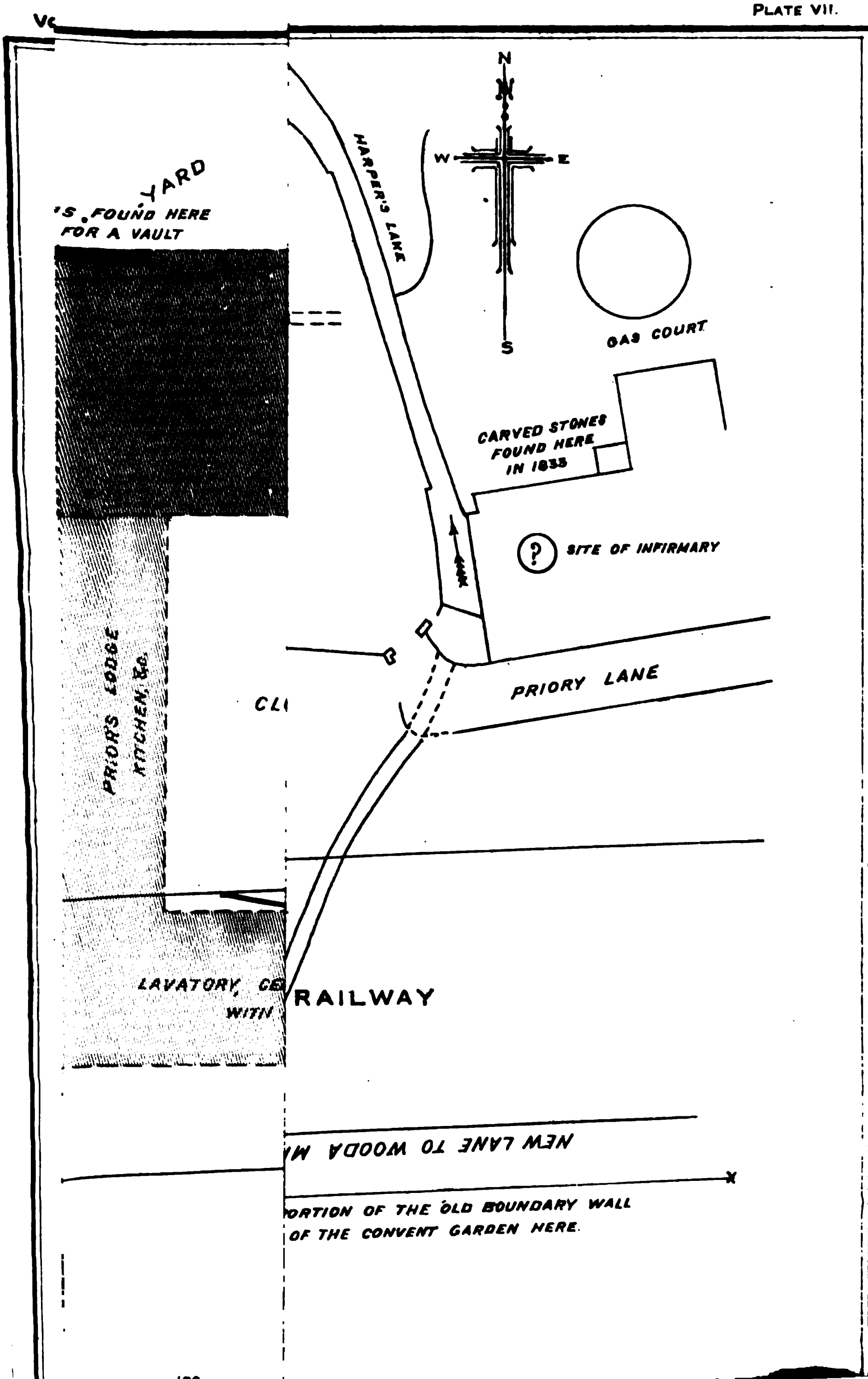
greatly the bird was held in esteem as a device, for it is, or was, displayed by no less than thirty-five Cornish families.

The chough is found as a crest, and in the shield, but not as a supporter of the shield. The Cornish chough generally occurs "proper," *i.e.*, in its natural colours, and as a complete bird, though in some cases it occurs with "head erased," *i.e.* cut off, as in the family of Tregonwell. Oftentimes appendages are added to the bill, as in the family of Tom of St. Petroc Minor, where the crest is a Cornish chough ppr., holding in its bill an escallop. The Cornish chough is generally depicted standing, though we have an instance to the contrary in the case of St. Aubyn of the Mount, where it is represented "rising," or "with wings expanded," as was borne by Humphrey of Truro; or, as Trewinnard, "3 Cornish choughs ppr., two in chief pecking and one rising." I have said that the choughs were generally borne "proper." There are some remarkable instances to the contrary. Rashleigh of Menabilly has a Cornish chough argent: *i.e.* white, almost a contradiction in terms, though not in Heraldry. It is also "legged and beaked gules," which would be "proper." The Cornish choughs of Stone are "or" (gold), and "vert" (green), and Tolcarne of Tolcarne, uses "3 Cornish choughs reguard, Az," (blue). It would be very difficult to give a description of the bird in Mayow's arms, which is described as "Erm" (Ermine), if it were not for the written account which tells us that it is a Cornish chough.

St. Thomas a Beckett.

It is now confidently asserted that St. Thomas a Becket was a Cornishman. This we distinctly know, that he was not, for he was born in London, the offspring of a Londoner, and a Saracenic woman, an account of whose romantic union is given by Johannes Brompton. Gilbert Beck, as his father was really called, was born in London in the reign of Henry I, and his master changed his name into Becket, and the commonality into Beckie. There seems to be nothing to connect St. Thomas in his life-time with Cornwall; the fact that a Cornish Becket bore the same arms as the Archbishop is not at all, I submit, substantial evidence. After his death, however, a child of Minster was raised to life by the father interceding to the saint, according to the account

given by William of Canterbury in his Miracula S. Thomæ (137)," who says "Filium suum nobis Henricus exhibuit, quem indubitantes mortuum fuisse perhibuit, Cumque morbi mortesque genus exhibuisset, quibus presentibus vita excessisset, quomodo per Martyrem vitæ restitu eretur, dixi non simplici verbo fidem posse fieri "Si" inquit ministra, quæ est villa territorii (diocese) exoniensis mecum tibi satis facere non protest, testi est mitú veritas quia mortuum credidi, quem vivum exhibeo. Sed et hoc subjacio quia per triduum post restitutionem spirituum solo spiritu palpitaret, non mamillarn maternam biberet, aut aliud aliquid, ut diceretur ad horam vivificatum propter consolationem parentum.


YARD
'S FOUND HERE
FOR A VAULT
HARPER'S LANE
N
W
E
S
GAS COURT
CARVED STONES
FOUND HERE
IN 1833
SITE OF INFIRMARY
PRIOR'S LODGE
KITCHEN, &c.
CL
PRIORY LANE
LAVATORY, CE
WITH
RAILWAY
NEW LANE TO WOODA M
ORTION OF THE OLD BOUNDARY WALL
OF THE CONVENT GARDEN HERE.

EXCAVATIONS ON THE SITE OF LAUNCESTON PRIORY,

(*Abstracted by permission from a paper read before the Launceston Scientific and Historical Society.*)

By OTHO B. PETER.

The Priory of Launceston was founded by William Warlewast, Bishop of Exeter, in 1126.

After the dissolution in 1536-9, the Priory buildings were levelled to the ground, and the site was subsequently used as a place for throwing refuse of every description. Thus all vestige of the once princely buildings became lost to view, and then to memory. Only the musty records of the methodical monks remained, and these being translated, fixed the site of the Priory again, but doubtfully, until the North Cornwall Railway Engineers in their excavations in 1886 unearthed the foundations of walls, which later excavations proved to have stood on the east and south of the Cloister Square. These foundations marked the site of the Day Room, the lavatory, cellarer's crypt, and other adjacent rooms. In the Day Room, which stood east of the Cloister, and ran north and south, was found the base of an octagonal column *in situ*; this column, which is now in St. Thomas Churchyard, was one of two, or three, which supported the stone groined floor of the Dormitory which was over it, Many of the simply chamfered groin stones were within the foundations. The Lavatory, and cellarer's crypt, &c., were situated under the Refectory, and ran west, at right angles to the Day Room; on their sites were found many more groin stones, an ancient candlestick, a silver (?) horse harness buckle, the upper portion of a stone hand-cornmill, and under the floor, long lengths of lead piping for the water supply; this pipe had, at one point, a very primitive junction where a branch pipe united with it. I am of opinion that it was supplied with water from an adit (the arch over which has lately been destroyed) close to the western entrance to St. Thomas Churchyard.

The Priory meadow has recently been offered for sale, and the Launceston Gas Co. having purchased a portion of it for the

erection of a gasometer, they commenced in May, 1888, to build a boundary wall around their plot. Unfortunately this plot proved, as we shall see, to contain the most sanctified portions of the Priory site. On the 29th May it came to my knowledge that in making excavations for the foundations of this boundary wall, a piece of carved stone had been found. I at once asked for, and obtained permission of the directors of the Gas Company, to make deeper excavations, and in the course of a few days a great number of similarly carved stones, and portions of coloured floor tiles were discovered. The carved stones most probably formed portions of the Choir Screen, and canopied tombs in the Priory Church.

During the month of June, the Chairman of the Gas Co., (Dr. Thompson), caused further excavations to be made, disclosing the bases of two beautiful Early English trefoil respond columns, from which the north and south aisle arcade arches sprang (the column on the south has since been erected in the St. Thomas Churchyard adjoining, and that on the north remains buried); and also the foundations of the south Chancel Chapel (which I suggest was dedicated to the Virgin) with its altar *in situ*; and the wall which carried the Choir Screen, two large fragments of which Screen were found.

In July the Gas Company commenced their deep excavations for the gasholder, and uncovered the whole of the foundations of the Presbytery, or Chancel, and the north Chancel Chapel, which I suggest was dedicated to St. Gabriel. These side Chapels had stone groined roofs, a great number of the groin stones covered with coloured plastering, being discovered within their walls; but judging from the mass of decayed roofing-slates found on the Presbytery site, I think it probable that its roof was of timber.

To the north, outside the Presbytery wall, were numerous graves, about 5 feet below the original, or old ground line. This was the Sextonshay, or Cemetery of the laity, the monks being buried in the Cloister Square A walled tomb and other graves, were also found within the walls. The walls of both the Chapels and the Presbytery were of great thickness, and supported by flat buttresses externally, the quoins and plinths

being of squared local free-stone. Internally the faces of the walls were plastered, the plastering in many places still retaining coloured designs in vermilion, yellow, and black. The site being a marshy one, the foundations were carried down to a great depth, the floor line being 5 feet, and the bottom of foundations from 10 to 11 feet, below the present ground line. The footings, or bottoms of the walls were built with courses of stone set on edge, each course sloping in a contrary direction to the one above it, just like one sees herring-bone hedging built in the moor districts now. These courses of stone were not set in mortar, thus the moisture drained through them, and left the superstructures dry. I only noticed one instance of wooden piles having been used, and that was under the foundation of the eastern wall of St. Gabriel's Chapel, where a few blackened posts were excavated.

The floors of the Church throughout the excavations were formed as follows:—A layer of stones was set on edge, earth thrown over them, and then rammed down level, on this, thin slates were laid, and on the slates, encaustic tiles. In addition to the great number of loose fragments of these tiles, I happily discovered one small portion entire, and also some full sized ones bearing capital letters, &c. The entire piece was in St. Gabriel's Chapel, close to its eastern wall, and it is singular that all the heraldic tiles, and most of those with capital letters on them, came from that site. The arms depicted are those of Royal personages, that of Richard, Earl of Cornwall, being the most conspicuous. The tiles found within the walls of the Presbytery were almost all of geometrical patterns. Some few with capital letters came out of the south Chapel. All the entire tiles, and all the fragments that could be saved, are now in the Launceston Museum. At Cleeve, Glastonbury, and Wells, are ancient tiles very similar to those found at Launceston.

There were signs of a step from the Nave floor to the Chapels, and the Presbytery, and projecting from the north wall of the latter, I found the foundation of the stall seats.

Numerous pieces of beautifully moulded arch stones, small circular shafts, window tracery, red ridge tiles, lead dowels

for securing stonework, and a few scraps of opaque glass, were turned out from day to day.

It was found impossible to save the ruins, but permission to remove the relics found was obtained. So the old walls speedily vanished under the pickaxe, and the stones which composed them were used to build a wall around the gasholder which now stands on the site of the Chancel of Launceston Priory.

Lacy, Bishop of Exeter, granted an indulgence in favour of the Chapel of St. Catherine, which was affiliated to the Priory, and had probably suffered during the then late riots. Where this Chapel stood is a disputed question, some assuming that it was built on the site of what we now know as the Alexandra, or Tresmarrow Slate Quarry, and others that it stood near the western entrance to St. Thomas Churchyard. A lane known as St. Catherine's lane ascends directly from the Priory to the former site, and the quarry itself has, for centuries, been known as "Catherine" or "Kattern Walls." Sculptured stones have been found there, and the shrubs and plants, still growing on the spot, indicate its former use. The latter site was occupied by the ruins of a building in the form of a Chapel until a few years ago, when the old walls were pulled down, the stones from them being used in building the adjoining bone mill. Leland points to the locality of this Chapel as being "by the west north-west, a little without Launstowne," and he adds "It is now prophanid."

During the priorate of Robert Waryn, viz. in 1478, a payment was made, to the receiver of the son of the reigning King, at the Chapel of St. Gabriel, in the Priory. I think this Chapel was that on the north of the Chancel. [See Plan.]

A Chapel of St. James is mentioned in the Charter of Philip and Mary to Dunheved, as occuping a site near the present St. Thomas Bridge, on the left hand as we descend from the Town.

I will here say a few words on the human remains recently exhumed inside and outside the walls of the Priory Chancel. The graves were formed as follows. Within vertical slabs of roughly trimmed stone, the bodies were laid horizontally with

the feet towards the east. No coffins were used. This was evident in all instances from the fact that the shoulder blades of the skeletons were quite close to the stones, leaving no room for intervening wood. The head stones were chiefly rough blocks of freestone, with places hollowed out to receive the skulls. Over the graves, three or four flat stones were laid, and then they were covered with earth. One or two of the skeletons were perfect, the teeth remaining in the jaws. Some members of the British Archæological Association state the above is the most primitive known manner of burying the dead, that the custom was derived from Pagan times, and that it was subsequently adopted by the Christians. All the human bones were reverently collected and, by the kindness of Mr. Cowlard, buried in St. Thomas' Churchyard.

Whilst William Hopkyn was Prior [1483 to 1507] the duties and rights of the worshippers in the adjacent Parish Church of St. Thomas were defined by Hugh Oldham, Bishop of Exeter, who was asked to settle disputes, which had arisen between the Prior and the neighbouring laymen. Amongst other things the worshippers at St. Thomas Church were to offer yearly a wax candle weighing one pound at the High Altar of the Priory Church, and give two shillings yearly to the Priest whom the Prior appointed to officiate in St. Thomas Church, and and it was also agreed that a Clerk should sleep in a certain chamber of the tower of the Convent Church, so that such Clerk might arouse the Curate of St. Thomas when it was necessary for him to rise to administer the sacraments. This Tower was probably at the western end of the nave; its position can easily be discerned by visiting the site and noting the outline of the present Churchyard hedge, which is over the site of the northern wall of the Priory Church.

Before I conclude, I should like to say a few words on the immediate precincts of the Priory. It was the rule to build boundary walls around the gardens, &c., which were attached to Monasteries. Traces of such boundary walls around Launceston Priory can still be seen. One started from the north-eastern corner of the Presbytery, where I found foundations, and a doorway leading to the Sextonshay, from that point it probably ran

straight to the present St. Thomas Street, and then at right angles to the southern side of the newly cut road to Wooda Lane at the foot of the Old Hill, where I think a portion of the wall still forms the lane boundary as far as Harper's Lake. From this point the stream may have formed a sufficient fence around the Convent Garden, which garden extended to the new cottages in Wooda Lane, and was bounded on the west by the present lane leat. I think it probable that the present existing mill pond was the site of an ancient fish pond attached to the Priory; and that the Priory barn and stables stood in the orchard on the north of the pond, old foundations having been found in this orchard in former years. The Priory Mill stood near the site of the present Town Mills. The railway cutting through the Priory meadow was again extended in 1891, but no further discoveries of interest were made.

ST. PETROC'S CHURCH, PADSTOW.

(Notes of an Address delivered in Padstow Church, August 20. 1891, to the Members of the Royal Institution of Cornwall, by the Right Reverend EDWARD TROLLOPE, D.D., F.S.A., Lord Bishop, Suffragan, of Nottingham,)

In Cornwall, four Churches dedicated to St. Petroc still remain, viz.: those of Padstow, Bodmin, Little Petherick, and Trevalga; and there are many others named after him in Devon and in Wales. He is said to have proceeded from Wales or from Cornwall to Ireland, and thence returned south (on a mill-stone across the sea) to Padstow (Petroc's-stow) in Cornwall, eventually settling, with three Welsh disciples, in Bodmin (also called Petroc's-stow,) where his relics* were long enshrined in his conventional church (since destroyed), the patron saints of which were St. Mary (the Blessed Virgin) and St. Petroc.

The site of Padstow Church marks that of a sacred edifice of extreme antiquity, and the Chapel of St. Sampson was not far from it. There are ancient crosses around. A very large base, from which rises part of a massive cross-shaft, is in the church-yard; another cross is in the Vicarage Garden; and a third is in the grounds of Prideaux Place.†

The Tower of the church does not appear to be Norman. It is Early English in style, with 14th century additions, and contains 6 bells which, according to the churchwardens' book, were rung in honour of Charles, Prince of Wales, afterwards King Charles II, when he entered Padstow (as the guest of John, son of Sir Nicholas Prideaux, then owner of Prideaux Place), on his way from Launceston to Pendennis Castle, after the disastrous battle of Naseby, fought June 14th, 1645. The

* A reliquary, which probably at one time contained them, still exists at Bodmin.

† All these Crosses have been accurately figured and described in the Journal of the British Archæol: Association (vol. 47, part 4, 1891); and in "The Builder," (June 6, 1891, vol. lx, p. 449), by Mr. Arthur G. Langdon, Architect, 17, Craven-street, Strand, London.

references are to payments made to "Nicholas Hutchinges for ordering the Prince's state, to the Ringers at the Prince's cominge, and to the Prince's Highness's servants."

The exterior of the church displays fine old roofs, and handsome windows, which last are uniformly constructed of Catacleugh-trap. The only difference being in those of the chantry forming the south chancel-aisle, these two being flamboyant, whilst between them outside is a figure holding a shield of lions, impaling the arms of Nanfan (3 wings), on the central buttress. On the buttress at each side, are mutilated quadrupeds, as supporters; apparently a lion and a chained unicorn.

The whole interior of the church is in the style of the perpendicular period, so general in Cornwall.

The Nave consists of five bays, its pillars and arches being of Caen stone. It is surmounted by a plaster roof, above which, the original timbers remain.

The Aisles, happily, retain their very pleasing timber roofs still open,—that is, free from plaster.

There is no Chancel Arch, but originally there were undoubtedly Screens between the chancel and nave and the chancel aisles, and, as certainly, lofts, above those of the north aisle and the nave; from the evidence of the position of the rood-loft Stair-case in the northern wall of the church. Perhaps the loft extended over the southern aisle screen too, for both aisles of the chancel were certainly chantry Chapels.

In the Sacrarium, on the south side, is a piscina surmounted by a canopy terminating in a figure of a saint, clad in gown and hood, holding a book in one hand and a staff in the other; according to some writers, erroneously stated to represent St. Petroc.*

In the richly carved soffit over the east window are introduced two shields; one bearing [azure] 3 salmon fess-ways [or], for

* Rev. W. Iago has identified this figure as that of St. Anthony of Egypt Patriarch of Monks. He holds the TAU-cross (St. Anthony's) as a crutch-stick, also a book, and below is a hog. These are the usual emblems of St. Anthony, who overcame the swinish demon of sensuality and gluttony typified by the animal at his feet. (St. Petroc's effigies shew him as an ecclesiastic, holding in his left hand the pastoral crook of a Prior, his right hand being raised in benediction).

Bodmin Priory; in reference to a grant made to its Priors (by Algar) of the whole fishery of the Alan or Camel; the other shield charged with a sword in pale between two letters P, each letter crowned,—a device to signify St. Petroc, probably.*

The Chancel Arcades are of two bays each; the arches and pillars of the northern being of granite, and in this respect differing from all the other arcades in the church. The closed roof of the chancel is of oak, with a prettily carved little cornice, from which rise at intervals figures of angels holding blank shields.

The following shields of arms formerly existed in the windows of this church, viz.: those of John, Earl of Cornwall, subsequently King of England; Edward, Earl of Cornwall, son of Edward I; Piers Gaveston, Earl of Cornwall, 1308; and John of Eltham, the last Earl of Cornwall, 1328. No old glass, however, now remains, except one small piece, in the head of one of the south windows, representing the emblem of St. Mark.

Through the generosity of the late Miss Mary Prideaux-Brune, the munificent restorer of the whole church, the windows were enlivened by modern painted glass, and a series of scriptural texts remarkably well chosen.

The font, composed of Catacleugh-trap, is interesting from its general design and its carving. It consists of a square base, a circular central pillar, and slender octagonal smaller pillars, supporting a circular basin,—on the sides of which are carved small figures of the Apostles and four angle angels as capitals of the smaller pillars, whilst two rows of pattrasses, on the lower portion of the basin, indicate the late or perpendicular character of the font.

The pulpit is for the most part modern, but incorporated in it are five panels, of the time of Henry VII, representing the instruments of our Lord's Passion, with a modern panel to complete the series. Commencing behind, on the north side, the

* A somewhat similar shield, viz.: one charged with a sword erect, crowned, and debruised by a bugle horn, between a hound and a hart lodged, occurs in the stone carving at Rialton in St. Columb Minor. It is labelled "S. Petrocus." This is shown in Rev. W. Iago's plate of Vivian sculptures, in the R.I.C. Journal, Vol. 5, p. 345,

subjects are the following, each panel having also a shell above; and a shield, of varying form, below.

1. Two halberts crossed; the lantern and two torches; together with St. Peter's sword, the ear of Malchus being upon its blade.
2. A helm surmounted by a crown of thorns; and, on the shield below, our Lord's pierced hands and feet, with his pierced heart between them.
3. The spear, with the sponge on hyssop, crossed, above; on the shield below, the pillar of flagellation surmounted by the cock; and scourges.
4. The cross, the crown of thorns, and the sponge on hyssop again. (This panel is the modern addition).
5. Crossed halberts, above; on the shield below, the three large nails; Judas's hand holding the bag of money; and the vessel of vinegar on round dish. (The two last* may, however, be otherwise explained).
6. The spear with the sponge on hyssop; and, below, a ladder between two scourges.

In the chancel is a seat, with two old bench-ends (15th century), which have been adapted recently to their present use. On the outer face of one is carved a fox in a cowled habit, preaching from a pulpit to some geese. On its inner side is inserted a carving of the cross and the crown of thorns. The other bench end has, on the outside, three hands holding as many dice; also the seamless coat; within, a hand grasping a spear.

The monuments in the church are of various kinds, and include the following:—

A memorial brass consisting of an inscribed plate,† lately renovated and inserted in the stone-step of the sanctuary. It commemorates Laurence Merther, who was Vicar of Padstow

* Possibly a hand gripping a torn-out beard; and the ewer and basin used by Pilate for washing his hands.

† A fragment of the brass effigy of a priest, in alb, with wrist apparels, amice, maniple, and chesuble, has more recently been found, and seems to form (with the exception of the head, which is lost) the remainder of Merther's brass. If so, his monument was semi-effigial with inscription plate.

from 1400 to 1421, on the presentation of the Prior and Convent of Bodmin. He was subsequently licensed to celebrate in the Chapels of Holy Trinity, St. Michael, St. Petrock, St. Gorman, and St. Wethlege.

One of the steps of the north doorway is a portion of a sepulchral slab. On it, part of the matrix of a brass may be detected, representing a female kneeling.

The fine monument of Sir Nicholas Prideaux, of Soldon, at the west end of the south aisle, was originally erected in the chancel of West Putford Church, Devon ; and thence brought here in 1732. It exhibits painted effigies of Sir Nicholas, with his two sons below him, one by his first wife, the other by his second ; opposite to him, his third wife, with her two sons below her by her former husband, Dr. Evan Morice, Chancellor of Exeter, viz. : Sir William Morice, Secretary of State to Charles II, and Laurence, who died young. All are shewn reverentially kneeling in prayer. There are two long inscriptions, and emblems of mortality, constituting adjuncts of this valuable memorial which so distinctly portrays the dress of Sir Nicholas Prideaux's period.

On the base is carved, in low relief, a figure of St. Christopher bearing the infant Saviour on his shoulders.

The next principal monument is at the west end of the north aisle. This is of marble and commemorates Edmund Prideaux, the father of Humphrey Prideaux, the famous Dean of Norwich. The latter, though born at Padstow, was buried in Norwich Cathedral, consequently there is no monument of him here.

Outside the church, within a covered recess on the north side of the tower, is the greater part of an incised slate sepulchral slab, commemorating Honor, wife of Robert Calwoodley, who died April 9th, 1521, as set forth on a border legend around a cross ; I am therefore happy to be able to state that she was not the member of her family who was charged, before the Star Chamber Bench, in 1592, with having committed a serious act of violence within this church, by the then mayor of Padstow, John Prideaux. That lady was Anne Calwoodley, who disputing the right of the mayor and others to the new seat they occupied, locked herself up in the church, and with a great axe began to

hew the seat down, and would not stop, when the mayor came in a hurry and begged her to do so. Subsequently, by might and force, she, in the time of divine service, with others, prevented him from taking his lawful place therein.*

Another of this family, viz.: John Calwoodley, mayor of Padstow, on the part of himself, the Corporation, and inhabitants of Padstow, made a series of complaints, in the 26th year of Elizabeth, against William Roche, a merchant of the same place; in that he, with other lewd fellows, about the feast of Easter last, had partaken of the Holy Communion in a common alehouse; and then entered the church, contemptuously looking upon those assembled there; he had also, it was alleged, during the last three years consigned to Spain corn and victuals, contrary to Her Majesty's prohibition; and about a year before, had beaten and wounded Margaret, the wife of Mr. Talbot, which was thought to have caused her death; and also another woman, to the danger of her life. It was stated likewise that he had defended certain robbers against the constable, had promoted certain broils and tumults in the town; that he had published and circulated divers slanderous and contentious "rymes and balletts" against divers of the honest people of Padstow; and spoken contemptuously of Her Majesty's Great Seal. Saying that he could make as good a one for two-pence! whence he (the Mayor) begged that the said Wm. Roche might be sub-pœnaed to answer for these offences before the Court of of the Star Chamber. It is further recorded that, after the hearing of this case, Wm. Roche so well defended himself and rebutted the charges, that the case was dismissed "with no great worship to them who bound him."†

* This account is taken from the Star Chamber proceedings at the Record Office, by Charles G. Prideaux-Brune, Esq.

† Star Chamber proceedings, 26 Eliz., Bundle 5, No. 30, Letter C.

COLOUR CHANGES IN CORNISH STOATS.

By HENRY CROWTHER, F.R.M.S., Curator of the Truro Museum.

In the Truro Museum are many types of more or less lighter coloured and white vertebrate quadrupeds. I cannot ascertain the precise dates of their capture, as the entry in our Journal of their gift to the Museum, does not of course include facts relating to the field. Most of them were given years ago, and several are in a case of Cornish mammals, presented by the late Mr. Clem. Jackson, of Port Loe. The animals grouped in this case must have taken the best part of a life-time to acquire, and include undoubted summer and winter forms. It would have been interesting to know, at first hand, under what conditions the country lay, when these lighter coloured and white mammals were caught.

I purpose here only to touch on the colour changes in the weasel family, of which the examples on the table are members. Mr. Jonathan Couch in his "Cornish Fauna" says of the weasel, "it is not common for this animal to assume a pied appearance in Cornwall, but it has done so in a not very cold season." In the second edition of this work published by our society this remark is deleted. In Bell's "British Quadrupeds," it is stated that Mr. Couch has seen a white form of stoat more than once in Cornwall. So far as I can learn from personal enquiries, the weasel is rarely seen white in Cornwall, and we have it on the authority of Mr. Bell, one of the most eminent writers on British Mammals, that "sometimes, though rarely, the weasel becomes white in winter."* The Rev. Mr. Jenyns in his "Manual of the British Vertebrate Animals" makes of the Weasel a "*Var.* β. White, with a few black hairs at the extremity of the tail," and of the Stoat "(*Summer dress*)" which is the brown form, and "(*Winter dress*) Wholly white, or white with a slight tinge of yellow, the extremity of the tail excepted, which remains black. *Obs.* In spring and autumn these two liveries are found intermixed."

*History of British Quadrupeds, 2nd ed., p. 188.

Mr. Bellamy in his "Natural History of South Devon" says of the weasel, "White specimens and others in progress of change to the white garb are occasionally found;" and of the Stoat, "occasionally found white, or pied, or blotched with white." We may take it I think that whilst colour changes do occur amongst the weasels, white forms are only occasionally met with in the south-west of England.

Both red and white types of the Common Weasel, ***Mustela vulgaris***, L., and of the Stoat, ***Mustela erminea***, L., are well represented in our Museum, the lighter ones in a larger proportion, as their greater rarity made them more curious to their collectors and donors. Amongst them we have illustrations of the various changes from ruddy red through buff and yellow to white. The collection bears out, too, common observation, that colour changes in Stoats are more frequent than in the Common Weasels. Recently Mr. Thomas Clark, of Truro, procured for us from one of the game-keepers of Mr. Claude Daubuz at Killiow, a stoat caught during the blizzard of last March, and from another game-keeper at St. Allen, another example of the same species caught immediately after the blizzard. The two examples were equally fine animals when living, but in colour are very dissimilar. The example, caught when Cornwall was under a mantle of snow, which fell as winter was almost over, when we had passed through a summer-like February, probably one of the finest on record, is, except a triangular spreckled patch of brown and white between the ears and nose, and the black tip at the tail end—which is never changed—beautifully white. The second example caught after the blizzard is brown.

In northern latitudes where the rigour of winter comes round with severe regularity, the stoat changes its dress with the season. Even in Britain, in the mountainous parts of the north of Scotland, this change is well marked, but further south it becomes rarer, and in many museums throughout the middle and south of England the white stoat is considered a curiosity.

The photographs which are thrown upon the screen are from lantern slides prepared by my friend, Mr. George Parkin, of Wakefield, from his collection of Stoats, and illustrate more effectively than words the colour changes of these animals in the north of England.

Some suggest this colour change has to do with mimicry. In biology this term has a pretty definite meaning, it was first used by the late Mr. W. H. Bates, and is the term given to the "advantageous resemblance (usually protective) which one species of animal or plant often shews to another." Mimicry is rather the adoption amongst animals and plants of deceptive resemblances. In the Weasel family the resemblance is not to living forms but to the ground, and this is usual with the higher animals, their colours generally matching their surroundings. Mimicry, though almost unknown amongst mammals, is common with birds and insects. An interesting case given by Mr. A. R. Wallace will perhaps make this difference clearer. In the Malay region he came across an insectivorous mammal (*Cladobates*) which closely resembled (mimicked) a squirrel in colour and bushiness of tail, but fed on young birds and insects, and not on fruit. The colour changes in the Stoats are in all probability secretive and not protective, as these animals can take care of themselves. The ordinary dress of the stoat is bicolored, white beneath, which never changes, and is hidden as the animal runs, and a visible dorsal brown which, as we have instanced above, may alter in tint.

I have seen several times, in the field, the use of the light coloured strip beneath the body of the Weasel family. I remember once when walking over Middleham Moor, Yorkshire, seeing two of these animals, which were crossing a ridge of ground and coming towards me. Suspecting danger they raised themselves on their hinder quarters until they stood full height, the white ventral strip, now fully visible, blended with the sky glare behind them which I was facing, and gave to each stoat the appearance of two narrow dark lines, totally unlike any living animal.

The following facts point to the variations in colour depending on coldness and snow: in our ordinary Cornish winters these vermiform mammals do not change their colour; the stoat caught in the blizzard was white; the specimen sent soon afterwards, when the weather was warmer and no snow upon the ground was again brown, as was a small example of a weasel sent a little later by Mr. Richards, the game-keeper at Killiow.

A few words on the effect of cold and snow on animals in boreal regions may not be out of place here, as the stoats are generally distributed throughout Arctic Europe, Asia, and America. In Arctic areas many animals remain white throughout the year, such as the Polar bear, American polar hare; others turn white in winter as the Arctic hare, Arctic fox, and *Ermine*. The permanently white forms live amongst the constant snows, the others in summer live in regions which are free from snow. Here colour is seen to be secretive. Records are plentiful of brown coloured stoats in our Cornish winters, and I have seen both weasels and stoats in their summer dress in mid-winter in Swaledale and other exposed localities.

Mr. Wallace in his delightful work on "Darwinism," says "whenever we find Arctic animals which, from whatever cause, do not require protection by the white colour, then neither the cold nor the snow-glare has any effect upon their colouration." In spite of odd exceptions snow and coldness have an effect on our Cornish stoats. With us, in all probability, the white specimens occur only when heavy snows are on the ground, a time of snow and coldness. Mr. Elliott Coues in his monograph on "Fur-bearing Animals," says "if the requisite temperature be experienced at the periods of renewal of the coat, the new hairs will come out of the opposite colour, that is the change may or may not be coincident with shedding." It is clear then that in snowy regions, should the cold persist, a prolongation of winter seem imminent, the white coat and not the brown is renewed.

A glance at our Museum specimens shews that the alterations in colour may be due to a change of the hair from brown to white, or a renewal of the brown hairs by white ones.

When we come to think these facts over, we shall see, I feel certain, that the colour variations in our Cornish stoats are more than commonplace. Remembering that the stoats universally and regularly change their coats in Arctic regions, in less colder areas only at certain odd times, and in still warmer places never changing them at all, it would seem that this odd and uncertain colour display points to ancestral characters. The varying dress refers us back to a time when the Stoats were more closely

restricted to Arctic tracts, where short summers were followed by rigorous winters, in the extended peregrinations of these animals they settled in warmer and still warmer areas till they overran Europe and found a home in Northern India. In some of these regions the colour change is useless, but though apparently forgotten, the power to alter the dress is not lost, but latent, two conditions—coldness and snow—being requisite to induce its display.

In the blizzard of March, 1891, we had in Cornwall the essentials necessary to influence this power, intense cold and an Arctic outlook. Hence, probably, in the Stoat before us, dormant ancestral characters pointing to the derivation of the animal from northern forms, are made visible, in a fur of singular whiteness and beauty.

LITTLE PETHERICK, OTHERWISE St. PETROCK MINOR.

BY THE

Reverend the Right Honorable SAMUEL VISCOUNT MOLESWORTH, M.A., Rector.

The church of St. Petroc in this Parish was re-opened for Divine Service on Wednesday, 6th October, 1858.

The church has been almost rebuilt. The general character of the old building has been preserved, the walls being built upon the line of the old foundation with the exception of an additional bay at the end of the north aisle to the westward.

The old church was much after the usual type of Cornish churches, consisting, in this instance, of only two long ridges, with a south porch and western tower, all unbuttressed and built of rubble slate stone with granite quoins.

The old north aisle was curiously cut out of the native schist rock, which was left to form the external wall, with the exception of a foot or two of walling work immediately under the roof. This primitive feature it was found necessary to sacrifice. The trickling in of water, from the wet earth, caused constant damp and unwholesomeness even in the summer months. This has been all now remedied, and the walls are built of slate stone and other stone of the neighbourhood in random courses.

The gables are finished with water-tablings and saddle-stones with bold granite finial crosses. The division of the nave and chancel is externally marked by a slight break in the roof and an ornamental metal cross.

The east window of the chancel is of stained glass, the design of Alfred Bere, of Exeter. The rest of the windows are filled with quarry-glass slightly tinted. The new windows in their treatment follow the style of the tracery of the old east windows, whose date was about the middle of the 14th century.

The new roofs are framed of Baltic fir, of strong, though light, construction.

Some of the new dressed and cut stone-work is of the deep grey close-grained stone called Kattaclugh or carracluse, which is always found, more or less, in old Cornish churches.

The outer doorway of the porch, presented by Mrs. Mary Prideaux-Brune, gives a good specimen of this fine stone; as does also the new arch, with its pillar, cap and base,—separating the chancel from the north aisle,—presented by Thomas Henry Peter, Esq., which once formed part of the now ruined church of St. Constantine in St. Merryn Parish.

Two small semi-detached capitals of the best middle-pointed period of architecture were discovered in the old walls of the tower. These are apparently of the Pentuan stone, which was much used in the best works of that age in Cornwall.

Amongst other reliques of past ages, a tombstone, thought by some,* who read it "Sire Roger Leinho," to be that of the founder, was turned up, and has been laid under a low arch purposely constructed for its reception on the north side of the Sacrarium. It is a flat stone with a simple floriated cross cut upon it in low relief, surmounted by a human head.

The church is filled with open benches of stained and varnished deal arranged on new floors.

The tower has been rebuilt from the foundations.

The situation of the church is unusually picturesque, at the bottom of a wooded slope rising almost abruptly from the banks of a pebbly brook; and is just such as to suggest to a writer of romance what a quiet, peaceful, rural churchyard ought to be; and, to many concerned in the present restoration, it is full of early recollections as well as hallowed by old associations.

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*The Rev. W. Iago (Hon. Sec.. for Cornwall, of the Society of Antiquaries) writes:—"By permission of the Rector and with the kind assistance of Mr. J. D. Enys, I have examined the slab in its very dark situation, and have taken several rubbings of it. The head, in relief above the cross, is that of an ecclesiastic,—the tonsure being very apparent. The name in the Norman-French legend is not Leinho. The words, as far as they can be traced, are:— + SIRE ROGER LEMPRV GIST ICI.—(M and P being conjoined). Sir was a title pertaining to many of the clergy. The name Lempru, Lemprew, Lempreur, Lempriere, occurs elsewhere. The slab is much like those at St. Breoke, Bodmin, St. Merryn, St. Burian, Tintagel, &c."

On the floor of the nave are the arms of Henry V (1413-1422) in modern tiles.

The chancel has a handsome reredos of tile-work, presented by Beatrice Lady Molesworth, widow of the late rector.

A lancet-window of stained glass is inscribed:—"In mem: Hugonis Henrici Molesworth, Bart., Rectoris; qui hanc ecclesiam restauravit. Obiit in fest: Epiph: 1862. Hanc fenestram posuit Georgius Gulielmus, Rector, 1867."

Another chancel-window of stained glass is inscribed:—"In mem: Catharine, conjugis carissimæ Georg: Gulielm: Manning, hujus Eccl. Rectoris. Obiit 13 Octr., 1864.

On the keystone of the tower arch is the Molesworth crest, the coat of arms, is displayed on a shield, supported by an angel, on an external bracket in the first stage of the tower.

St. Petroc is said by some to have been a native of Wales, —by others, of Cornwall,—who crossed over to Padstow, A.D. 518, and afterwards settled at Bodmin, where he died, A.D. 564. He had previously spent 20 years in Ireland, chiefly in studying the bible. His feast day was 4th June.

Inscription on a monument under the east window:—

"Heare under lyeth the body of John Bettye, the sonne of Humfrye Bettye, Clerke, who was buried the XXVIII day of June, Anno Dom. 1634.

Si Christum discis satis est si cetera nescis,
Si Christum nescis nihil est si cetera discis."

[The preceding description of the church of St. Petroc Minor was read by Lord Molesworth, the Rector, to the members of the Royal Institution of Cornwall on the occasion of their visit, August 20th, 1891. An account of St. Petroc, the patron saint of Padstow, Little Petherick, Bodmin, &c., appears in the 3rd Vol. of this R.I.C. Journal, written by the late Rev. J. Adams, M.A., of Stockcross. See also Sir J. Maclean's "Trigg Minor Deanery," Vol. 1, p. 121. The Mediæval Bells in Little Petherick Tower are noted by Mr. Dunkin in his "Church Bells of Cornwall," pp. 46-51].

ON THE ORIGIN AND DEVELOPMENT OF ORE DEPOSITS IN THE WEST OF ENGLAND.

By J. H. COLLINS, F.G.S. *

CHAP. III.—ROCK CHANGE AS CONCERNED IN THE FORMATION OF ORE DEPOSITS.

SEC. 1.—*General Characters of the Ore-Deposits.*

In presenting the following brief outline of the general characters of the West of England ore-deposits, I must assume that the main stratigraphical features of the district, and in particular the relations of the granite and elvan to the stratified rocks, are known to the reader.†

Ore-deposits are frequontly and conveniently classed as contemporaneous (ore-beds, &c.), secondary or derivative (lodes, &c.), and detrital (placers, &c.) A more detailed, and at the same time more accurate classification is that given below, which is substantially the same as that adopted by Mr. J. A. Phillips in 1884.‡

1. *Superficial.* *a.*—Deposits formed by the mechanical action of water, air, &c., in the denudation of mineral regions.

   b.—Deposits of chemical origin formed at the earth's surface by precipitation in lakes and back waters, by organic agencies, or by the issue of mineral springs or metalliferous vapours.

2. *Stratified.* *c.*—Deposits of ore-substance constituting the bulk of metalliferous beds, which have been formed *in situ* by precipitation from aqueous solutions, and subsequently but little altered.

   d.—Beds in which the ore-substance originally deposited from solution has been subsequently altered,

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* Continued from the *Journal*, No. 36, p. 149.

† For convenient summaries of this part of the subject see Mr. Henwood's "Address" Journ. Roy. Inst. Corn., XIII., 1871, and the present author's "Sketch of the Geology of Central and West Cornwall," Proc. Geol. Assoc., X, 3, 1887.

‡ "Ore-deposits," p. 3,

variously re-arranged, and sometimes locally concentrated by metamorphic action.

e.—Ores disseminated through sedimentary beds, in which they have been chemically deposited after the consolidation of the beds.

3. *Unstratified.* *f.*—Stockworks.
g.—Impregnations.
h.—Segregated veins.
i.—Pipe veins.
j.—Pockets.
k.—Bedded veins or floors.
l.—Gash veins.
m.—Contact deposits.
n.—Rake veins or lodes.

Of course, it must not be forgotten that in nature there is no such hard and fast separation into groups as our classification would indicate—such grouping is merely adopted for convenience of study. The practical miner, and the observant mining student, will be constantly meeting with phenomena which in some respects would be best referred to one class—in others to another.

Of these various kinds of ore-deposits those classed as superficial are, in the West of England, for the most part of the (*a*) class. As they are to be separately dealt with in Chap. IV, they need not be further alluded to here.

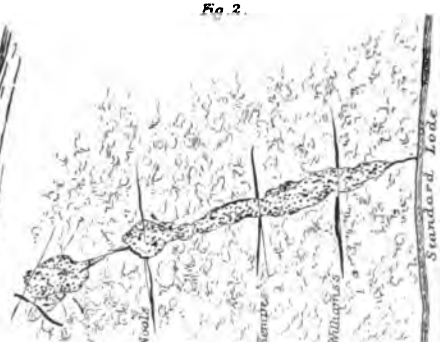
Stratified deposits in the West of England are rarely, if ever, of the (*c*) class, the rocks being too ancient. Some examples of those referred to, classes (*d*) and (*e*), will be given in the next section of the present chapter.

Fahlbands may be defined as slightly impregnated or mineralized belts of stratified rocks, coincident in strike and dip with the general country rock. They are often traversed by fissure lodes which extend beyond the limits of the fahlbands. While the lodes are in the unimpregnated country they are barren and valueless, but where they traverse the fahlbands they are notably metalliferous. These phenomena are particularly noticeable in the Kongsberg silver district in South Norway and in the Gympie gold district in Queensland. They are not exactly paralleled by any of the mineral phenomena of the West

Fig. I.

Mulberry.
1 inch = 3 feet

Fig. 2.

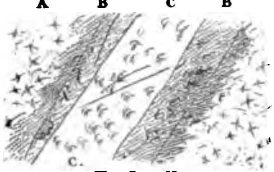


St Ives Consols.
1 inch = 60 fathoms

Fig. 3.

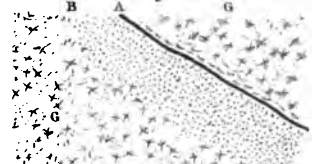
East Wheal Lovell.
Plan; scale $\frac{1}{500}$.

Fig. 4.



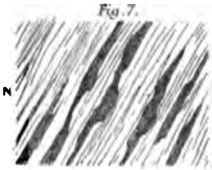
The Lovell.
A.A. *Granite*; B.B. *Cab*;
C.C. *The Lode, 4 to 10 feet wide.*

Fig. 5.



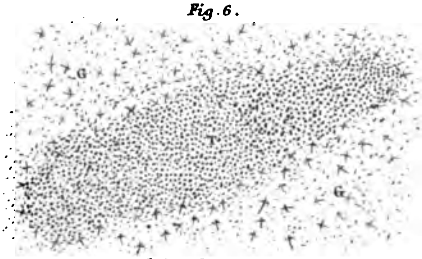
Balmynheer.
A. *Slide*; B. *Stanniferous Rock*; G. *Granite*.

Fig. 7.



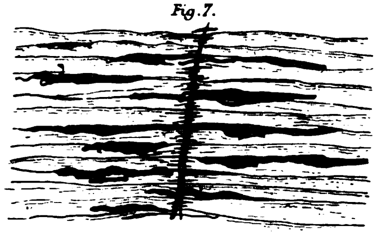
Parka Mines.
Section.

Fig. 6.



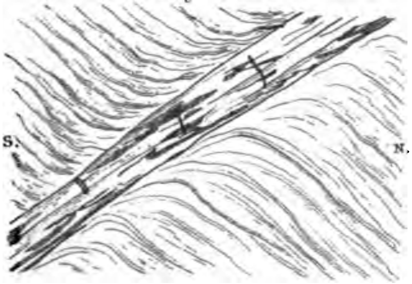
South Wendron, *Plan.*
G. *Granite*; T. *Stanniferous rock, about 40 x 50 ft at this section.*

Fig. 7.



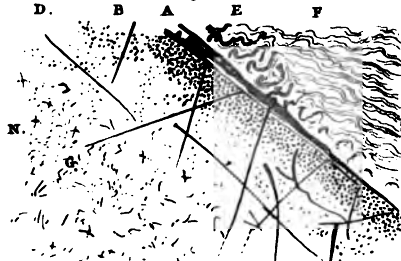
Parka Mines.
Plan.

Fig. 9.



Duchy Peru Lode
shewing bending of strata.

Fig. 8.



Flat Lode, Wheal Uny
130 fathom level. $\frac{1}{2}$ inch = 1 foot.
A. *Leader*; B. *Lode*; D. *Greyback*; E. *Capel*; F. *Killas*; G. G—

SPRAGUE &

of England; yet in a certain sense the belt of killas country near the granite junctions may be regarded as analogous.

Unstratified deposits will be considered in this chapter in a slightly different order to that set down above, and, of course, omitting those which are not clearly represented in our mining region. Thus we have no really characteristic pipe-veins, gash-veins, or contact deposits, although some of the ore-masses present notable analogies to these.

True segregated veins of metalliferous mineral are also somewhat rare in the West of England, although there are numerous examples of segregated non-metalliferous veins, of hornblende, axinite, garnet, and especially of quartz.

Well-marked pipe-veins—such as are common in the North of England, are also unrepresented, though some of the pockets and carbonas to be hereafter described present close analogies; typical gash-veins, such as those of the Mississipi valley, are also rare,* but the tin-deposits at the Parka mines near St. Columb are in many respects similar.

Again, I do not know of any typical contact-deposits—although it will be seen hereafter that many of the lodes are in fact contact-deposits, lying between granite and killas or killas and elvan for considerable distances, both in strike and underlie. In a certain sense, too, the stockworks at Carclaze and Cariggan may be looked upon as owing their mineralization to their position of contact.

Of stockworks, impregnations, chambers or pockets, and bedded veins or floors, the West of England presents excellent and very instructive examples, and of rake-veins or lodes proper, probably some of the best and most characteristic examples to be found in the world. Examples of each of these will be given in some detail in the following sections.

SEC. 2.—*Examples of Stratified Ore-Deposits.*

Mineral deposits formed *in situ* (*c*) and practically unaltered since their first formation are, as already stated, not known in the West of England—the stratified ore-beds which exist do in fact invariably afford evidence of much re-arrangement, or local

* Phillips' Ore-deposits, p. 93.

concentration of the ore-matter (group *d*), if not of actual impregnation from without since their first formation (group *e*), so that they can hardly be described as truly contemporaneous. Excluding some of the tin stockworks, which as will be seen hereafter have in a certain sense a claim to be considered as contemporaneous ore-beds; excluding too the beds of pyritous shale which exist in many parts of the district but which, hitherto have not been proved to be of economic importance,* we have only to consider in this place such interbedded ore-deposits as the magnetite of Haytor, the cupriferous beds of Belstone Consols and its neighbourhood, and the altered dolomite beds of Ashburton and Veryan, with their manganese concentrations; together with the manganiferous slates of South Sydenham and other places in Devonshire.

Perhaps the most definite examples of bedded-ores existing in the West of England are those situated at the foot of Haytor, in Devonshire, and the adjoining deposits at Smallacombe—the former described in 1875 by Dr. C. Le Neve Foster,† and the latter some years earlier by myself.‡

At the Haytor mine are four beds of magnetite, varying from 3 to 14 feet in thickness, with a total of 26 feet or more. These are interstratified with highly silicified slates and sandstones of carboniferous age—the whole series dipping pretty steeply to the north-north-east, and abutting against the granite, the bounding line of which runs here nearly north and south. An intrusive sheet of granite is partly interbedded with and breaks across the altered carboniferous strata, but the actual "junction" here as in so many other places seems to be a fault of a date much subsequent to the intrusion. With the magnetite, and especially near its planes of contact with the enclosing slates, there is much hornblende, garnet, and axinite; and a little to the westward, at Smallacombe, the whole series is very much

* See Boase, Trans. Roy. Geo. Soc. Corn. IV, p.p. 176—191. Mr. Boase says "at Tresuck iron pyrites enters so abundantly into the composition of these rocks that it is entitled to be considered as a constituent, and not as an adventitious mineral." (p. 191).

† Quart. Jour. Geol. Soc., 1875, p. 628 (with references to earlier descriptions in the Phil. Mag., 1827 to 1831).

‡ Report Miners' Assoc., 1872, p. 71.

decomposed—the slates here forming a kind of clay, and the sandstones being largely disintegrated into sand. In these soft beds are to be seen irregular layers of nodular limonite, while certain less decomposed beds still contain much magnetite and hornblende in an almost unaltered condition. Here, and also at several points along the outcrop—which may be traced for about a mile to the eastward—quantities of ochre and umber are met with irregularly disposed in the decomposed mass, and evidently themselves decomposition products.*

As to the origin of these beds, Dr. Foster, in the paper already referred to, remarks that "beds of iron-ore deposited contemporaneously with shales and sandstones seem to have been subjected to a metamorphic action—probably due to the proximity of the granite. The iron-ore—perhaps originally in the form of beds like the Cleveland ore—has been altered into magnetite, whilst the change undergone by the shales and sandstones consists in an extreme silicification."† I quite believe that this is the true explanation after a careful microscopic and partial chemical examination of the rocks and associated minerals; and I see no ground for the second supposition put forward by Dr. Foster (though hesitatingly) "that the apparently stratified magnetite may have been formed by ferruginous emanations which accompanied or followed the granitic intrusion, and spread out between the planes of bedding."‡ There is no evidence whatever of the existence of an actual "fissure" or "junction" vein which has served for the channel for "ferruginous solutions or emanations." I have little doubt that the original ferruginous beds consisted of carbonate of iron, that the heat from the proximity of the granite, aided by water circulating through the beds, has converted it into magnetite, and has also produced and developed the hornblende, axinite, garnet, &c. The general silicification of the fine-grained shales and sandstones seems to me to have been a subsequent process. It has produced in some places a kind of quartzite and in others a fine-grained banded

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* In these beds large masses of *gramenite* were visible at the time of my visit in 1871. See *Min. Mag.*, vol. 1, p. 67.

† Q. J. G. S., 1875, 629.

‡ p. 630.

cherty-looking rock—shewing its origin plainly under the microscope, and containing in one instance over 95 per cent. of silica.*

The silica of these rocks has something of a chalcedonic character, shewing very few traces of crystallization. The same period and mode of silicification is perhaps indicated by the occurrence in the neighbourhood of the rare mineral Haytorite —which is a chalcedonic pseudomorph after Datholite.

A somewhat similar association of bedded magnetite with hornblende, axinite, and apatite interstratified with "greenstone slate" or "hornblendic slate" occurs at the Crown's Mine, Botallack, and was briefly described and compared with the well-known Perseberg deposit in Sweden by Dr. Foster, in 1867.† Similar beds of magnetite have been worked to a small extent at Treluswell, near Penryn, and at Brent, in Devon.

The nodules of argillaceous iron-stone associated with the bands of sandstone, shale, and anthracite, of the "carbon series near Bideford, reminding us of the intermixture of iron-ore and vegetable matter in the bogs and morasses of the present day," were referred to by Sir H. Delabeche many years since,‡ but they have never, I think, been worked.

The red hematite of the Permian rocks in the neighbourhood of Luckham and Wotton Courtney, in West Somerset, has been "in some localities worked in the manner of a quarry for that ore, and profitably exported in the state in which it is thus roughly obtained....the hematite constituting as much a part of the beds as the sandstone and conglomerates with which it is associated."§

Another series of metalliferous beds, of considerable geological if not economical importance, occurs on the north side of Dartmoor, and extends from Sourton to South Zeal—a distance

* The practical importance of this silicification to the miner was shewn by the fact that the adit driven from the Smallacombe side for the purpose of opening up the magnetite beds in depth cost in some parts over £50 per fathom in driving. This however was before the use of boring machinery and of dynamite had become at all general in the West of England.

† Report Miners' Association, 1867, p. 46.

‡ Report on Cornwall, &c., p. 125. At page 143 he says on the same series of deposits "The general character of the great carbonaceous deposit of Devon…… ……is that of drifted matter, vegetable remains included…………in this respect it appears unlike the coal deposits of Northumberland and Durham" (p. 143).

§ Ibid, p. 197.

of seven or eight miles. The beds of ore, locally termed lodes, consist of garnet rock, mostly crystalline, containing large quantities of iron-pyrites and mispickel, with some disseminated copper-pyrites. These beds are interstratified with "perfectly conformable" dark siliceous slates, and the whole series dips pretty regularly away from the granite.* The economic importance of these beds might, I think, be greatly enhanced by a system of raw-smelting before export, so producing a matte which would better bear the cost of carriage, and which would be more readily saleable than such low-grade ores as are usually met with in this district.

The dark slates extending from Launceston to Lew Trenchard are everywhere permeated with manganese, which at many points seems to be gathered into lenticular or irregular masses having their greatest extensions mainly conforming to the strike and dip of the beds, so forming what have been termed "bedded veins," but sometimes so regular in form as to appear true beds—at others expanding into irregular masses or "pockets." Many of these have been worked very extensively and have in former times, when manganese was high in price, yielded large profits to their owners.

That the Haytor, Bideford, Luckham, Treluswell, and Botallack iron-ores, the copper-ores of Belstone and Sourton, and the manganese ores of Launceston, Lifton, and Lew Trenchard, are truly contemporaneous in their first origin, there is, I think, no reason to doubt; of mineral infiltration into the rock substance since its consolidation, other than in some instances an infiltration of silica, there seems to be no evidence whatever. It is equally certain however, that the ore-matter in them has been re-arranged and concentrated since the beds were first formed. This is in fact usually the case with contemporaneous ore-beds whenever their age is considerable—as for instance the concretionary iron-ores of the English coal measures, and notably the well-known bituminous copper-schists of Mansfeld;†

* The workings on these cupriferous beds at Belstone, which seem to greatly resemble many metalliferous deposits in South Norway were described by Sir W. W. Smyth, in the year 1868. See *Trans. Roy. Geol. Soc., Corn.*, IX, p. 38.

† For a clear though condensed account of the deposits, see the admirable treatise on "Ore-deposits," by the late Mr. J. A. Phillips, F.R.S.

and sometimes this concentration has been so extreme as to bring the deposits into a condition resembling "bedded veins" (*k*).

The transference and re-arrangement of pre-existing mineral matter is still more marked in the case of the altered dolomites at one time largely worked for manganese in the neighbourhood of Ashburton, and described by Mr. R. J. Frecheville in 1884* as examples of local concentration and re-arrangement of originally manganiferous beds. From the analyses presented by Mr. Frecheville, it seems that the concentration has been of a chemical and residual nature—carbonates of lime and magnesia have been carried off in solution, while the carbonates of iron and manganese present have been converted into peroxides.† The deposits of manganese at Combemartin, Newton Abbott, and Veryan have probably had a similar origin.

In other mining regions such "contemporaneous ore-beds" are extremely common; reference has already been made to the copper schists of Mansfeld—I may also refer to the copper slates of Wicklow, where the "sulphur course" displays the same schistosity with the "country rock," and to the cupriferous shales of Hon-peh, in China.‡

The "segregated veins" of Phillips (Ore Deposits, p. 90) seem to have much affinity with the ore-beds above described, but they are usually much less regular in thickness. I do not know of any well-characterised example in the West of England, unless the E.W. "lodes" at the Parka mines near St. Columb, hereafter to be described, are such.

Examples of impregnated stratified deposits (group *e*) are not very numerous in our mining region, but they are not altogether wanting. The evidence of cupreous impregnation in

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* Trans. Roy. Geol. Soc., Corn., x, 217.

† These and some associated derivation beds have been worked for many years for *umber*, of which 2,766 tons were produced in 1883.

‡ These consist of soft argillaceous rock filled with "light-green films and specks of malachite and chrysocolla in the cracks of cleavage and stratification"—or else siliceous bands "containing specks of cuprite with the green oxidized minerals also conformable—and occasional pockets of "pure copper-ore" (impure oxides with a little unchanged sulphide permeated by streaks of carbonate, and assaying up to 70 per cent). There are no mineral veins—the primary sources of the mineral are sedimentary, and the patches must be ascribed to the redeposition of the metal by infiltrations of solutions derived from other sources of unoxidized minerals in the adjacent rocks." See Becher, Quart. Jour. Geol. Soc., 168, p. 494.

the red sandstone conglomerates resting on the lode at West Doddington in W. Somerset is perfectly conclusive; here the lode-fissure itself may have been the channel through which the cupriferous solutions were introduced subsequent to the consolidation of the rock. The copper in the sandstones consists of impregnations and concretions of blue and green carbonate—similar to those of the Alderley Edge sandstones in Cheshire; it was formerly worked on a considerable scale.*

SEC 3.—*Examples of Stockworks.*

In many mining regions, bands or belts of "country-rock" are found which are traversed by numerous thin veins—or their numerous joints are thinly lined—or they are sprinkled throughout with small spots of metalliferous substance; the whole mass being thus rendered of considerable value. An ore-mass of this character is called by the Germans—from whom we have derived many of our mining terms—a "stock," and a working upon such a mass a "stock-werk" or—as the term has been adopted in England—a "stock-work."

Since the individual strings or nests of mineral are usually insignificant, it is necessary in stock-work mining to remove the whole mass of impregnated rock and to treat at any rate the greater portion in order to concentrate and separate its valuable contents. As the ores so distributed are often very small in quantity compared with the whole mass of the rock, *e.g.* with copper ores 1 per cent. or less and with tin ores from 3 to 10 lbs. of tin oxide to the ton, a concurrence of favourable circumstances is necessary to enable them to be worked with profit - such as cheap labour, land of little agricultural value on which to deposit the refuse, a good outlet for the said refuse so as to keep the workings clear, a good supply of water for concentration purposes, and, if possible, water-power for crushing, a body of the impregnated rock so large as to permit of working on a considerable scale, a genial climate allowing work to be carried on without serious interruption, &c. Even with all these advantages many are so poor that they remain unworked, and very few will pay to work except as open quarries.

* Delabeche, Report, &c., 609, and Leonard Horner, *Trans. Geol. Soc., Lond.*, III, pp. 352, 363.

Stockworks in the West of England have I believe only been worked for tin and for copper. Tin stockworks have been worked in ordinary "killas," and in that modification of it known as tourmaline schist; also in granite and several of its modifications, as greisen and schorlyte; and in several kinds of felspar-porphyry (elvan). Copper stockworks have been worked in killas and in granite.

Some of the larger tin stockworks in killas, as for example Mulberry and Minear Downs, seem to be very nearly related to the contemporary ore-beds already described, since they are often entirely unconnected with anything like a definite workable lode, and only very rarely with one that will pay of itself for working. But the strike of the belt of the impregnated ground is not necessarily or usually that of the general country rock, while its dip is usually much steeper than that of the beds. The chief individual strings are usually still more steeply inclined or even vertical, and, as will be shewn hereafter, these strings contain a notable proportion of the whole mineral contents of the belt, and nearly the whole of that which is extracted or extractable by the simple methods in use, and which are nevertheless in most cases the only ones economically possible.

The tin stockworks in altered granite usually conform in strike to the direction of the nearest junction with killas, but these also seem to be often unconnected with definite lodes.

Examples illustrating each of these varieties of "stockwork" will be described in the following order:—

1. Tin stockworks in killas apparently unconnected with any workable lode. *Examples*, Mulberry, Wheal Prosper, Minear Downs.
2. Tin stockworks in killas plainly connected with workable lodes. *Examples*, Great Wheal Fortune, Pednandrea.
3. Tin stockworks in "granite" unconnected with lodes. *Examples*, Carrigan, Cligga.
4. Tin stockworks in granite connected with lodes. *Examples*, Beam, Balleswidden.
5. Tin stockworks in "elvan." *Examples*, Wheal Jennings, Terras.

6. Copper stockworks in killas. *Example*, Wheal Music.
7. Copper stockworks in granite. *Example*, Wheal Vyvyan.

1.—TIN STOCKWORKS IN KILLAS UNCONNECTED WITH LODES.

Mulberry. This is one of the most ancient open tin workings in Cornwall. It is situated on an elevated "down" (Mulberry Down) about 2 miles to the N.W. of Lanivet Church. The excavation is at the bottom about 400 yards long and 30 wide, with a depth varying from 80 to 120 ft., but more tinny ground still stands on the east side of the pit. The then condition of the workings was described by Dr. C. Le Neve Foster in 1876 as follows:—"The killas, which is of an ash-grey colour, dips at an angle of about 45° in a direction N. 22° W. (*true*). It is traversed by numerous branches or veins running N. 7° W., dipping about from 80° W. to 90° (vertical), and varying from mere joints to veins 4 or 5 inches in width, rarely more than a foot apart—in fact generally only a few inches (fig. 1., plate VIII). Many of the veins preserve their independence for a considerable distance without intersecting other branches; but at the same time it is easy to find junctions both in the dip and in strike; sometimes also two adjacent strings may be connected by a "floor" or vein of tin following the stratification. In addition to tin the veins contain quartz and a little arsenical pyrites and wolfram."*

The average result of the operations is stated at that time to have been 7 lbs. of tin-oxide to the ton of stuff, which at the then prevailing low price paid expenses and a little more.

Wheal Prosper and Michell is half-a-mile westward of Lanivet Church, and was also described by Dr. Foster in 1876. The workings here are also in killas. The pit is 800 yards long, 30 yards wide at the bottom, and averages 90 ft. deep. The killas is soft and light-coloured (white, grey, yellow, brown), and is full of little veins running E. 7° N., and containing quartz, gilbertite and cassiterite, the impregnated mass being wider and the veins somewhat more productive where certain stanniferous caunters cross the pit (or rather, as I think, certain non-stanniferous caunter veins become stanniferous in crossing the pit).

* Quart. Journ. Geol. Soc., 1876, p. 655.

The produce here did not exceed 3 lbs. to the ton in 1876, which then paid expenses.*

At *Minear Downs*, a little to the N.E. of St. Austell, is another of these stanniferous channels of killas, lying between the famous Charlestown mines and the granite. The works were visited by the Miners' Association in 1870, and a short account was given in the report of proceedings of that year.† Dr. Foster described it six years later as follows—"The great open quarry....is about 200 yards long at the top and 60 or 70 yards wide, but only 90 yards long and 20 or 30 yards wide at the bottom. The greatest depth can scarcely be less than 120 feet. ..... The tin-ore occurs in a series of more or less parallel veins in the killas, striking about E. 7° S. and dipping N. at an angle of about 70°; the strings are often mere cracks but occasionally 7 to 8 inches wide, and lie from 2 inches to 12 inches apart....ten strings in one place in a width of 6 feet. They generally keep their own course without much interlacing in dip and strike. The killas itself dips S.S.E. at an angle of 20° to 25°, so that the strings intersect it almost at right angles. At the sides of the strings the killas is often stained red and yellow, and is occasionally altered into tourmaline schist. On the S.W. side of the pit is a so-called lode which is merely a mass of tourmaline schist 6 or 8 inches wide between two tin branches."‡

These works are still being profitably carried on, but the pit is very much larger than at the time of Dr. Foster's visit. It must now be at least 500 yards long and 150 feet deep. I visited it in the present year (1892), and found over sixty heads of stamps at work. The stuff is said to yield about 4 lbs. of tin to the ton.

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* On this point Dr. Foster remarks as follows :—

" Some of the reasons why the stuff can be treated so cheaply are :—

1. The rock is soft and friable and easily stamped.
2. The tin-ore is in large grains (crystals), consequently the rock need not be stamped fine, and the subsequent washing operations are greatly facilitated.
3. The substances mixed with the tin-ore are specifically very much lighter and easily separated by washing. There is no pyrites to necessitate calcination.
4. There is water power at command.

† p. 39.

‡ Ibid, p. 656.

Other large tin stockworks, differing little in essential character from those just described, exist at Gover, near Burngullow; at Tolldish, on Tregoss Moor; at Fatwork,* near St. Columb (in well-defined tourmaline schist); at Wheal Whisper, in Warleggan; and many other places, but never far from the granite, and often directly at the contact with it, or with elvan courses. There are probably many others which might be worked, but that they do not unite a sufficient number of the favourable conditions indicated above.

2.—TIN STOCKWORKS IN KILLAS CONNECTED OR ASSOCIATED WITH LODES.

Great Wheal Fortune. This mine is on the eastern border of the parish of Breage, a little to the south of Great Wheal Vor. Two well-known east and west tin and copper lodes traverse the sett and dip to the southward at angles near 45°. One of these has been worked to a depth of 80 fathoms or more with considerable advantage, but has been idle for many years. Two series of nearly vertical tin veins known as the "Conqueror" and "Elizabeth" branches appear at surface at about a furlong's distance to the south of the outcrop of the main lodes, and have been worked upon at intervals for many years in an excavation as a stockwork. These branches probably are connected with the main lode at a depth of 100 fathoms or a little more. The principal excavation runs nearly S.W., is about 400 feet long, 50 feet wide, and 60 feet deep. It is crossed by an elvan course which plainly heaves the branches to the left, and seems to enrich them. The average produce of the stuff stamped during the past few years has been 12 lbs. of tin to the ton. As the scale of working has been small, and steam power has been necessary for pumping and for hauling the stuff from below the adit, this has scarcely paid expenses, although on a sufficiently large scale it would certainly have been profitable, since the tin is of high quality, and the ground easy.

The great open-work on the back of the "south lode" at Drakewalls, was a kind of stockwork. The killas stockwork at Polberrow in St. Agnes is well-known. Another stockwork in

* Boase, *Trans. Roy. Geol. Soc., Corn.*, IV., p. 250; Henwood, *ibid* V., p. 120. According to Boase much of the rock at Fatwork has a brecciated appearance "like a lime-ash floor," yet there is no well-defined lode known there.

killas in connexion with a lode exists at Wheal Coates, on the hanging-wall side of the Towan-rath lode, and, when worked some years since yielded about 25 lbs. of tin to the ton of stuff.*

Pednandrea. The underground stockwork here was worked to a very considerable extent, about a quarter of a century ago. It was thus described by Mr. H. C. Salmon, in 1862:—"This great deposit, which in the old working was, I believe, called the Great Carbona, is what the Germans would call a Stockwerk. For a length of 25 fathoms at the 68 fathoms level, the tin made in branches in the killas "country," by the side of the lode for 11 fathoms wide, the lode itself being only 4 feet wide."†

I have been informed that the average produce of this belt of tin-ground was about 25 lbs. of tin to the ton, which was scarcely enough to cover the expenses of excavation, hauling, crushing, and dressing, with the additional cost of pumping and timbering at that depth. Had it been at the surface it would of course have paid handsomely.

The aggregate of tin-ground removed and treated in the killas stockworks just described cannot be less than 375,000 cubic fathoms, or say 6 million tons, and is probably much more. The average tin produce has been about 6 lbs. to the ton in those works which are unconnected with definite lodes, and 18 lbs. to the ton in the others. At least 20,000 tons of black tin must have been obtained from them in the aggregate, besides that lost in the tailings, to which reference will be made later on.

3.—TIN STOCKWORKS IN GRANITE UNCONNECTED WITH LODES.

The granite in which disseminated tin-ore occurs is almost invariably altered into greisen, schorlyte, or zwitter. I proceed to give examples of each.

Carrigan. This mine is on the left side of the turnpike road, going from Bugle to Lanivet. The open-work here is in a mass of greisen (essentially quartz and white mica), and is 100 yards long, 50 yards wide, and 20 deep. "On the S.E side it is bounded by a large clay vein or flucan, and on the north it disappears under the alluvium of the neighbouring valley. The

*Foster, Trans. R. G. S. C., IX., p. 212.

†Mining and Smelting Magazine, 1862, pp. 143-4.

rock is a mixture of quartz and (white) mica with a good deal of schorl, some gilbertite, and a little iron-pyrites, fluor, and cassiterite. The mass is traversed by a number of so-called *leaders*, which are quartz veins with tin-ore, schorl, gilbertite, and clay, dipping 85° N., and running E. 7° N. Very often they are an inch or two inches wide, and from 1 foot to 6 feet apart. Occasionally the *leader* adheres to the enclosing rock by one side only, and has a clay vein on the other. On washing the clay broken crystals of cassiterite are generally found, proving, I think, that since the deposition of tin-ore in the fissures there has been a movement of the walls. 27,500 tons of rock were stamped (*i.e.* a few years before 1876), and yielded 64 tons of tin-ore, or 5·2 lbs. of tin per ton, say ¼ per cent. It was expected that the wholly virgin ground would produce 8 lbs. of tin-ore per ton."*

Oligga. The interesting tin deposits at Oligga have long yielded a little tin to men washing the beach-sands, and picking a little here and there on the cliff face, but have never been systematically worked on a large scale. The remarkable alteration of the granite into parallel bands of quartz, stanniferous and schorlaceous greisen, and kaolinized granite with unaltered or little altered granite between, was well described and illustrated by Dr. Foster, in 1876. "The cliff section exhibits a countless number of these veins, varying from ⅛ inch to 6 inches in width, and from a few inches to a few feet apart." There are some pseudomorphs of chlorite or schorl after orthoclase, and the killas a little inland is converted into tourmaline schist at its contact with the granite. Dr. Foster suggests that the original fissures here were "contraction fissures," and that subsequently these were "penetrated and altered by metalliferous solutions arising from below,"† and it would seem that the direction of these fissures was determined by the foliation previously produced by the lateral pressure which has contorted the neighbouring killas. The more extensive conversion of the granite into greisen, at Carrigan, just referred to, is a change of the same character.

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* Foster, Quart. Journ. Geol. Soc., 1876, p. 657.

†See "Tin lodes of the St. Agnes district." Trans. Roy. Geol. Soc., IX, pp. 213, 219.

Carclaze. This famous open-work is two miles northward from St. Austell. It is now worked almost exclusively for china clay, but was formerly worked for tin only; its records, it is said, date from the time of Henry VII. The most recent published description of Carclaze is that given by Mr. R. Symons in our Journal. Mr. Symons found the area to be, by actual survey, 13 acres, and the greatest depth 132 feet.* This shows a very great increase from the 6 acres surveyed by Mr. Thomas, previous to 1846,† but the extension has been almost entirely in the "clay-beds" to the northward, and scarcely at all on the schorlaceous and stanniferous branches. At the time of Mr. Thomas's visit in Jan., 1830, there were 8 stamping mills at work, shafts had been sunk 10 fathoms deeper than the bottom of the pit, and the mine was said to be rich in the bottom. The clay was merely refuse, to be washed out through the adit as speedily as possible. He calculated that one million tons of stuff had been thus removed.

The schorlaceous tin branches run nearly E.W. and parallel to the junction with the killas (tourmaline schist); they vary from a fraction of an inch up to 2 feet in thickness, the thicker ones being almost devoid of tin. The greatest length of the workings, including the eastern part known as Little Carclaze, is nearly half-a-mile, and the total quantity of tin-bearing ground removed must be at least one million tons, besides several million tons of non-stanniferous clay ground. The pit must now (1892) be at least 18 acres in extent at the top.

Rock Hill. The abundance of schorl in connexion with the tin at Carclaze, is still more noticeable at Rock Hill. This hill is situated to the left of the turnpike road from St. Austell, and about half-a-mile short of the village of Bugle. A number of tin lodes formerly worked with considerable advantage in the Rocks mine, just under the turnpike road, converge at Rock Hill, where they have been worked at intervals for generations in an open quarry. Very little has been done there for the past few years, so that my description of the place, published with sketches, in 1873, needs but little alteration now. It runs as follows:—"The main excavation is of a nearly circular form, not much less than 150 feet diameter, and about 40 feet deep.

* Journ. Roy. Inst. Corn., IX, p. 140, 1877.
† Henwood, Trans. Roy. Geol. Soc., Corn., V, p. 120.

Opening from this on the east side is another excavation, about 100 feet long, 30 wide, and 20 deep. The hill consists of granite, the felspar of which is in parts completely decomposed, forming masses of china clay, interspersed with grains of quartz and flakes of mica" (carrlazyte). The main pit is crossed by a large caunter tin lode, or rather a tin-bearing belt of ground having no distinct walls. This runs nearly N.E., and dips steeply N.W., it consists chiefly of schorl and quartz, but contains on an average from 6 to 8 lbs. of tin to the ton of stuff. It is crossed by another belt of very similar character, running nearly N.S.; this is known as the cross-course, although it in no way resembles the ordinary cross-courses of the West of England; it appears slightly to heave the "lode" however, and itself contains tin (especially) near the intersection, sometimes as much as 20 lbs. to the ton.

Besides the "lode" and the "cross-course," a great number of smaller lodes and branches traverse the pit in almost every direction, many of them coming together about the centre of the pit, a little to the east of the point of intersection of the two greater masses. At some of the intersections rich bunches occur, some yielding 50 or even 60 per cent. of oxide of tin, and from one such bunch 17 tons of tin were got out about the year 1870.* From 1872 to 1874 the average produce of the stuff treated was about 10 lbs. of tin per ton of stuff crushed, or about 7 lbs. per ton of stuff broken. A very careful and economical mode of working was adopted, but it was on too small a scale, rarely exceeding 150 tons per week, and as the stuff was extremely hard, the stamps were worked by steam, and even the water for dressing had to be pumped by steam power, the mine barely "paid cost," even when black tin was selling at £90 per ton, and when the price fell to a little over £60, the works were abandoned. Still, taking into account the chances of meeting with occasional rich bunches, I think the abandonment was certainly premature.†

* Report, Miners' Assoc., 1872, p. 67, published 1873. See also "The Hensbarrow Granite District, pp. 40-47.

† The interesting occurrence at this mine of porphyritically embedded pseudomorphous crystals of schorl, quartz, oxide of tin, and of mixtures of two or three of these together, in the form of felspars, and also the occurrence in cavities of the rare mineral achroite was described by the writer in the year 1876, in the Mineralogical Magazine, Vol. 1, 1876, p. 55,

Other stanniferous masses of schorl-rock occur at Boscaswell Downs in St. Just, while the famous Roche Rock itself contains small quantities of tin.

Gonamena. A most remarkable mass of stanniferous granite was formerly worked at Gonamena, at the foot of Caradon Hill; the excavation is stated by Mr. Henwood to be 11 acres in extent, and 8 fathoms deep.* He also mentions a similar but smaller excavation near the Cheesewring. These have not, I think, ever been worked for china clay, but the working of the tin has certainly been facilitated by the partial kaolinization of the felspar. The same may be said of the rather extensive excavations at Kit Hill, and at Two Bridges on Dartmoor.† Others occur at Raggy Rowel, on the east side of Tregoning Hill, in Breage, and many other places; want of water alone prevents very many of these from being profitably worked.

The aggregate area of these "granite" stockworks can hardly be less than 250,000 cubic fathoms, or, considering the abundance of schorl which increases the specific gravity of the rock, over 4 million tons—averaging little, if at all, less than 8 lbs. of tin to the ton, or, say 14,000 tons of black tin.

4.—TIN STOCKWORKS IN GRANITE CONNECTED WITH DEFINITE LODES.

These have been very much richer than the deposits just described. A very common mode of occurrence is as a pair of well-defined lodes, enclosing a belt of highly stanniferous country between them. The famous deposits at Balleswidden, Beam, Bunny, and Birch Tor, are of this character.

Balleswidden, Parish of St. Just. At this mine Awboys lode and the south lode ran parallel, about 20 fathoms apart, for a distance of nearly a mile. There were other lodes crossing these obliquely at various points, the situations of all of them being clearly explained in the paper of Messrs. Rowe and Foster, in 1878.‡ It must not be supposed, however, that these lodes were at all like the great master lodes of the Carn Brea district; they

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*Trans. Roy. Geol. Soc., Corn., Vol. VIII, p. 665.

†Ibid, V, p. 132.

‡Rowe and Foster, "Observations on Balleswidden Mine." Trans. Roy. Geol. Soc., Corn., X, pp. 10 and 17. A very well illustrated and valuable paper throughout.

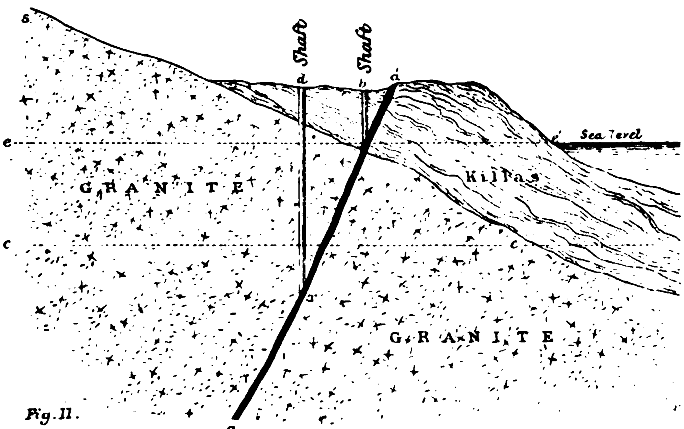

Fig. 11.

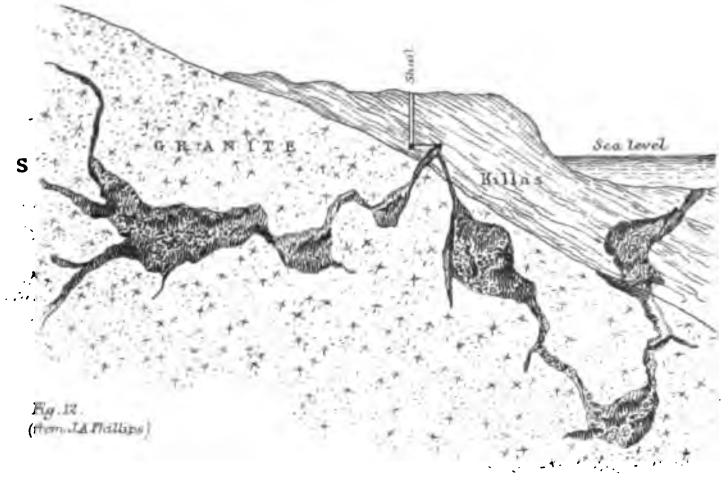

Fig. 12.
(from J.A. Phillips)

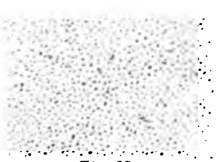

Fig. 13.

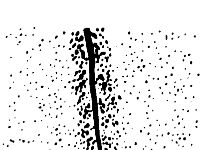

Fig. 14.

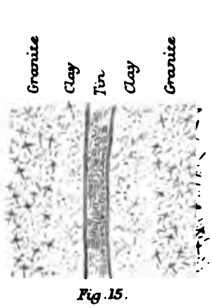

Fig. 15.

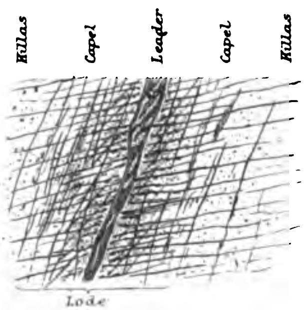

Fig. 16.

were always far more complex in character. "The dip is S.W., varying from 75° at the S E. part, to 60° at the N.W. extremity of the workings. The structure of this lode deserves particular attention; the so-called lode consists of four or five small parallel tin veins, bounded on each side by a hard rock locally known as *hardwork*, which merges into granite. The total width of the lode varied from 10 to 20 feet, and averaged about 12 feet. Each little vein or *leader*, known at Balleswidden as a *gry*, was generally about a half-inch thick and rarely widened out to more than 4 inches. The *gries* rarely united with one another along the dip or the strike, but often dwindled away to a mere string or joint. The filling up of these little veins consisted of coarsely crystallized tin stone, with schorl, quartz, gilbertite and kaolin (*prian*); a little wolfram, fluor-spar, bismuthine, and native copper were also sometimes met with. The little veins or gries were continually varying in productiveness; as a rule only one of them was rich in any given section, and as soon as it began to dwindle away one of the neighbouring ones began to improve. There was always a sharp and well-defined *wall* between the *gry* and the adjoining *hard-work*, and this was of importance to the miner as it enabled him to separate the rich gry from the poorer rock adjoining it, and make a little parcel of best work." The greater part of the tin was contained in the "gries," but the hard-work also contained a little tin. Associated with the so-called lodes were certain off-shoots or "pie-lodes," which much resembled the carbonas of the St. Ives district, yet to be referred to, but differed from them in containing less schorl and more gilbertite when really productive. The mine was worked to a depth of about 150 fathoms. During the 36 years that the adventure lasted, from February, 1837 to April, 1873, more than 12,000 tons of black tin were sold, of a value of £694,094, besides certain small quantities raised and sold before and since.*

Beam. This mine is about four miles north of St. Austell, on the north side of the Hensbarrow granite. It is many years since it was worked, and the latest published description is that given with plan and sections in my "Hensbarrow granite district," in 1878. It is said to have been first worked as an open cutting in

* Ibid, p. 17.

the time of Henry VII, for the sake of the two chief "lodes" and the impregnated "country" between. Early in the present century regular mining operations were commenced on these two lodes, which were only 5 or 6 fathoms apart, but diverged somewhat in depth. The lodes bear from 16° to 18° N. of E., and vary from a few inches to 6 feet in width, dipping steeply to the northward. They are composed of quartz, schorl, and tin-ore, with a little wolfram and black copper-ore, and much clay and gilbertite; they have also yielded small quantities of iron-ore at certain points. The mine was worked to the 82 fathom level, by Messrs. Williams of Scorrier, until about 1830, when it was abandoned "on account of its poverty," according to Mr. Hawkins,* having yielded about £30,000 profit to its owners. Subsequent workings carried the mine a few fathoms deeper, but no large amount of work was ever done below the 92 fathom level.

The lodes were always richer where the country was soft. When the lodes were small they often consisted of almost solid tin ore, but if large, a central "pith" or "leader" of tin occurred as a double crystallized coating upon crystallized quartz.†

A very similar association of "lodes" with tin impregnated country was also worked on a considerable scale at the Bunny Mine, about half-way between Beam and St. Austell, but no record of the results is obtainable, and the "lodes" seemed to die out at a moderate depth.

Birch Tor. The deposits of this mine seem to have been pretty much of the character just described. Mr. Henwood says that the veins united in depth, that the works were very ancient, and that specular iron-ore occurred with the tin.‡

Two things have been especially noted in connexion with these deposits, first, that the stanniferous belts of the surface became more concentrated into definite "lodes" in depth, and second, that as a whole the deposits were, as in the corresponding cases of killas stockworks, much richer than the stockworks properly so-called, which are not connected with definite lodes.

*Trans. Roy. Geol. Soc., Corn., IV, p. 477.

† "The Hensbarrow granite district."—Truro, Lake and Lake, 1878.

‡Trans. Roy. Geol. Soc., Corn., V, p. 132.

Thus, we have seen that the average produce of the granite stockworks proper has been about 8 lbs. to the ton of stuff removed. Only a very rough approximation can be made to the mass value of the Balleswidden stuff, but it certainly seems to have been much richer than this. If we estimate the ground removed at 300 fathoms long, 4 fathoms wide, and 40 fathoms deep; and few would be disposed to reckon anything like so much, who have seen the workings and studied the plans; then the ground removed, allowing for that left for pillars, could not exceed 500,000 tons, and this would require to yield about 50 lbs. of tin to the ton to account for the 12,000 tons sold. The current statements as to the riches of Beam and Bunny would certainly indicate a somewhat similar state of concentration for the tin of these mines.

Of course this greater concentration is to some extent apparent only, since the greater expense of working underground, and at a considerable depth, would compel the miners to leave much of the poorer ground below, and untouched, which if raised and treated would materially lower the average produce. But after making due allowance for this consideration, it yet appears that when the main-joints in a stockwork are so well-defined as to appear more or less like distinct lodes, an enrichment is the result, in other words the riches bear some direct relation, speaking generally, to the "strength" of the strings, veins, or lodes.

The total ground excavated for this class of stockworks can hardly be less in all than four times that worked out at Balleswidden, and the tin thus obtained must have been from 40,000 to 50,000 tons .

5 —TIN STOCKWORKS IN ELVAN.

Many elvans have been worked as tin stockworks to a small extent, as for instance Polgooth, near St. Austell; Terras, in St. Stephens; Budnick and Wheal Coates, in St. Agnes; Castle-an-dinas and Belowda, near Roche; Poldory, in Gwennap; Wheal Unity Wood, and Bissoe Bridge.* Very rich tin-ores were also obtained by under-ground mining at the Wherry Mine near Penzance, in an elvan course 18 feet wide. "On a close inspection

* Henwood, Trans. Roy. Geol. Soc., Corn., v, 82, 87,

of the mass in which the tin is thus abundantly dispersed (over 1 per cent. as it appears), the grains appear of a crystalline transparency, and so equal in size and regularly distributed as to form as it were one of the constituent parts of the porphyry,"*

Wheal Jennings. This mine is situated in the parish of Gwinear, and was formerly worked under the name of Parbola. Mr. Seymour, who gave a very good illustrated description of the mine in the year 1876,† does not regard it as a true stockwork "because the tin-bearing branches follow (mainly) one direction," but as we have seen this is the case at Mulberry and many other recognized stockworks. The elvan traverses a somewhat soft killas, and contains many small veins of tin which mostly pass across it from killas to killas, others falling into them in their course. Some pass into the killas after traversing the elvan. The elvan itself contains disseminated grains of tin, forming masses known as "grey-tin," also angular masses of "granite." Mr. Seymour regards the tin veins as shrinkage-fissures subsequently filled by means of stanniferous solutions which arose through the fissured mass, "where the mass of rock was in a greater degree porous, the emanations penetrated into and impregnated the adjacent elvan, thus forming the deposits of so-called "grey-tin."‡

Belowda Hill. A large elvan cuts through the granite at Belowda Hill, and both rocks are found to be stanniferous in an open-cutting which has been worked at intervals on a considerable scale. Dr. Foster wrote a short note on the works here, which appeared, in the year 1875, in our Journal. He stated that the "lode" was 40 feet wide at the time he saw it, and that the stanniferous belt so-called was traversed by numerous tin branches from 2 inches to 6 inches wide, which carried quartz, schorl and tin—some tin being found in the intermediate masses of rock also, in some cases as pseudomorphs after felspar. He states that the general produce of the stuff was one-half per cent.§ In 1880 I superintended the works here for a short time, during which a battery of stamps was set up and several hundred tons

* John Hawkins, Trans. Roy. Geol. Soc., Corn., Vol. I, p. 140.

† Trans. Roy. Geol. Soc., Corn., IX, p.p. 185, 195.

‡ Ibid.

§ Journ. R.I.C., V, p. 213.

of stuff were stamped. The "overburden" gave 5 lbs. to the ton, the granite about as much, and the elvan 12 lbs. during these trials, which just paid expenses but no more, on a scale of 20 to 30 tons per day.

The total quantity of elvan removed in this class of stockwork may perhaps be reasonably estimated at one million tons, and the average produce at one-half per cent., or say 4,500 tons in all.

6.—COPPER STOCKWORKS IN KILLAS.

These are rare in Cornwall, but there are the remains of several to be seen along the north coast to the west of St. Agnes.

Wheal Music. This mine is situated about 2 miles to the north of Scorrier station, and it has not, I believe, been worked for about 60 years. Mr. Henwood states that it was worked on well-known lodes for many years, and that at length these were up split into minute strings and branches, none of which were singly worth pursuit. The whole rock was then removed and the copper ores extracted. An excavation of an elliptical form of about an acre in area, and 25 fathoms in depth, yet stands open to the day. About four millions of cubic feet must have been removed. It closely resembles the net-work of the tin veins in granite at Carclaze."* The copper it appears was mainly in the form of copper-pyrites, but this was often converted superficially into malachite; the country rock was tourmaline-schist of a bluish grey tinge.†

Copper disseminated in an ancient conglomerate occurs in the form of copper-pyrites, at Bellurian Cove,‡ and native copper was found disseminated in the serpentine at Wheal Trenance, in the same parish of Mullion; a fine mass from this place may now be seen in the Museum of Practical Geology in London. Writing of this place in 1818, Mr. Ashurst Majendie says "The mines of copper have been discontinued. I was informed that at low water in spring tides, narrow veins of native copper may be observed in the serpentine, where it is covered by the sea.§

* Trans. Roy. Geol. Soc., Corn., v, 98, note.

† Ibid, p. 98 and 235.

‡ Delabeche, Report, &c.. p. 31, note.

§ Trans. Roy. Geol Soc , Corn., I, p. 38.

7.—COPPER STOCKWORKS IN GRANITE.

Wheal Vyvyan. This ancient mine is in the Parish of Constantine. A belt of the granite, some 5 to 10 fathoms in width, was found to contain disseminated copper-pyrites, iron-pyrites, a little grey-ore, and a little tin. This belt was traversed by numerous veins or strings, which consisted of minute crevices lined with tin-ore. Certain veins of granite in the "lode" heaved or displaced these strings, as did also a series of cross-courses.*

A somewhat similar mass was formerly worked at Trumpet Consols, in Wendron. In this instance the copper was argentiferous, each per cent. of copper carrying from 2 to 4 ounces of silver per ton.†

Sec. 4.—*Impregnations, &c.*

Under this head it will be convenient to refer to certain deposits, known as Carbonas, pockets, floors, bedded veins, and gash-veins which differ decidedly on the one hand from true metalliferous beds, and on the other from true fissure lodes—and which are usually much more concentrated and defined than stockworks, and also in general much smaller. Like stockworks they are often though not invariably connected with definite lodes.

Carbonas. These have so far only been found in West Cornwall, and in granite. The great carbona at St. Ives Consols was connected with the standard lode at the 78 fathom level by a kind of pipe only a few inches in width and height.—(See fig. 2, Plate III). "It has been traced about 120 fathoms in length, and in that distance dips 40 fathoms, but it is nowhere more than 10 fathoms either in vertical thickness or in breadth, and is generally much smaller. It sends off lode-like shoots or branches laterally, and terminates in the standard lode."‡ Very similar bodies have been worked at Rosewall Hill Mine, at Wheal Speed, Balnoon, and many other places. The chief lodes

*See Henwood, Trans. Roy. Geol. Soc., Corn., v, 73.

†It is worthy of note that most of the copper of this side of the Stithians granite mass is argentiferous. Thus some grey-ore found at Trumpet Consols in 1885, contained at least 3 ounces of silver per ton for each per cent. of copper.

‡ Henwood, Trans. Roy. Geol. Soc. of Corn., V, p. 237.

at Balnoon were known as the Garth and the North Vervis Veins; but "besides occasional enlargements of the lodes from a few inches to 30 or 40 feet in breadth, there are still larger masses of tin ore wholly unconnected with any vein, and surrounded on all sides by an extremely hard and very coarse-grained granite. These are discovered almost by accident, for I have known more than one of them found by extending the excavation where there existed no other indication than a mere joint in the rocks, which contained no mineral, and was perceptible only from the slow oozing of a minute quantity of water between its faces."*

East Wheal Lovell. This mine is in the parish of Wendron, and the remarkable tin deposits discovered in 1875 were thus described by Dr. Foster. "The lodes are usually very narrow, sometimes a mere joint or line of division in the rocks—but occasionally a couple of inches thick; they consist of quartz, a little clay, and red oxide of iron, and *per se* are utterly valueless. In some places however you get curious deposits of tin on both sides of the vein (fig. 3, Plate III), occupying very little space but extremely rich, consisting of kaolinized granite containing much gilbertite and schorl."† The importance of these deposits is indicated by the fact that from very small workings, tin to the value of £39,000 was sold in a period of 20 months from October, 1869, to May, 1871, yielding a profit of £27,000. At one time the end of a drift in one of these bodies was valued at £1,000 per fathom.

The Lovell, Wendron. A very similar deposit, also in altered granite, occurs here—the lode itself being somewhat more defined (fig. 4, Plate III) and very productive in certain shoots or "pipes." The tin in the "lode" C.C. was accompanied by blende and chalcopyrite, as well as by schorl, gilbertite, kaolin and quartz.‡ The "cab." B.B, was composed of quartz, mica, gilbertite, chlorite, pyrites, chalcopyrite, and schorl; and like the "lode" was traversed by joints containing nothing but a little schorl, gilbertite, and kaolin. In fact if it had contained

* Henwood, *Trans. Roy. Geol. Soc. Corn.*, V, p. 20.

† Trans. Roy. Geol. Soc. Corn., IX, p. 167. The paper is well illustrated.

‡ Foster, Quart. Journ. Geol. Soc., 1878, p. 640.

a little more cassiterite it would have been reckoned as a part of the lode.

Balmynheer. This is another mine in Wendron where the granite is impregnated with tin under but not over a "slide" composed of clay, with a little quartz and mica, and about 6" thick. "The tin-rock is a mixture of quartz, chlorite, gilbertite, iron-pyrites, zinc-blende, tin ore, and a little wolfram." It is from 20 to 30 feet thick, and has been worked to a depth of 30 fathoms from surface.* (fig. 5, Plate III).

South Wendron Mine adjoins the Lovell. The tin-ground here (fig. 6, Plate III) is a very regular cylindroid of stanniferous rock merging gradually on all sides into granite, with its axis dipping at an angle of 49° from the horizon in a direction N. 25 W. (true). The longer axis of the oval section of the pipe varies from 20 to 60 feet, whilst the shorter is about 10 feet. The mass consists of quartz, mica, gilbertite, a little iron pyrites, and tin stone. The workings extend to a depth of 46 fathoms from the surface, and consist of a shaft and a few short levels or lateral excavations. "The characteristics of these three deposits may be summed up in a very few words, they are masses of stanniferous rock passing gradually into the surrounding granite."†

The deposits just referred to afford illustrations of a regular series of impregnations and accompanying alterations of granite rocks—commencing with a notable impregnation connected with and starting from a master lode of considerable value (St. Ives Consols), followed by examples related indeed to veins or joints —at first stanniferous (East Wheal Lovell), then altogether barren (Balmynheer), and finally reaching an example which seems to be altogether unconnected with anything that can be called a vein fissure. These modes of occurrence are illustrated in plate III, figs. 2 to 6.

In other districts these irregular tin deposits would be spoken of as pockets, although they one and all lack one character of a true pocket, since they do not appear to be deposits in pre-existing cavities.

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* Ibid p. 648.
† Ibid p. 651.

Floors. These have relations on the one hand with the impregnations just described, and on the other with the "gash-veins" and "bedded-veins," which are so characteristic of many limestone districts. Tin-floors in granite or other eruptive rock seem to be mere local expansions of the lode passing between approximately horizontal joint-planes for a certain distance.

In stratified rocks aggregations of ore lying between bed-planes are often known as "bedded-veins" or floors—of course such aggregations coincide in position with the beds, lying horizontal or standing highly inclined as the case may be, though they would only be called floors by the miner when horizontal or nearly so. At Botallack tin-floors occurred in the killas—at the junction of the killas and granite—and in the granite. In one instance seven successive tin-floors were noticed, separated by beds or layers of ferruginous slate and schorl, and they yielded according to Mr. Hawkins about 1 per cent. of black tin.* Similar floors occurred formerly at Wheal Reeth and at Wheal Vor.†

The most interesting examples of this kind of formation of recent working occurred at the Parka Mines in St. Columb, and were described by Dr. Foster in 1874. The lodes here were of very little importance, but certain lateral off-shoots from them lying between the bedding planes of the killas (fig. 7 and 8, Plate III) were extremely rich. If the killas had been here approximately horizontal, these interposed off-shoots would have been called floors by the miners.‡ The average produce of the tin stuff treated was in 1874 more than 5 per cent., and in that year the mine yielded 231 tons of black tin—a remarkable yield from a mine not more than 43 fathoms deep.

SEC. 5.—*Examples of true fissure Lodes.*

(*a*) *General characters of lodes.* Lodes are, as Mr. Henwood has very truly observed, "the principal repositories of metals and

*See description by Hawkins, *Trans. Roy. Geol. Soc. of Corn.*, vol. 11, p. 31. Carne *ibid* pp. 326-331. Henwood, *ibid* v, p. 13. *note.* It is much to be regretted that neither of these authors has given a sketch section.

† Henwood, *ibid*, p. 328.

‡ Report Miners Association of Cornwall and Devon, 1875.

ores in the West in England."* Mr. Henwood uses the word "lode" in the practical miner's sense, that is, he includes the whole of the workable band of mineralized country by the side of the fissure as well as the actual fissure-filling, whatever may be its nature, whether ore-leader, flucan, vein-stone, breccia, or capel. In this sense a lode may be defined as a metalliferous band or deposit occupying or bounding a fissure of inconsiderable thickness as compared with its length (rarely more than $\frac{1}{1000}$th and often less than $\frac{1}{10000}$th) and extending to a great or unknown depth. Using the term then in this sense, Mr. Henwood gives in a number of useful tables the results of his very numerous observations on the lodes of Cornwall and Devon as regards direction, inclination, width, and principal contents. Referring my readers to the original "address" for numerous and important details, I merely extract for use in this enquiry the following particulars.

1. The mean directions of the lodes in the different "districts" of the West of England are:

St. Just, ..	35° S. of E.	Redruth, &c.,	22° N. of E.
St. Ives, ..	8° S. of E.	St. Agnes ..	22° N. of E.
Marazion ..	1° N. of E.	St. Austell ..	13° N. of E.
Gwinear, &c.	2° S. of E.	Caradon ..	18° N. of E.
Helston ..	16° N. of E.	Tavistock ..	9° N. of E.
Camborne, &c.,	20° N. of E.		

The *average* bearing throughout being about 5° N. of E., "a range not materially different from that of the granite which appears at intervals between Dartmoor and the Lands End."†

*Presidential Address, 1871. *Journal Royal Institution of Cornwall*, XIII. In a practical sense this dictum is unquestionable, although the present essay will shew that even from this point of view the stockworks, and other "irregular deposits" are worthy of somewhat more consideration than was given to them by our excellent President, while from the theoretical and scientific side they are of the highest possible importance.

†*Ibid*, p. XVI. This generalization is no doubt an important one—yet it may probably lead to serious misconceptions, for, 1st as to the mean bearing for the whole county, it is manifestly of little use to make up an average from such incongruous elements as appear in the table given. 2nd, an equally important criticism of Mr. Henwood's mean directions for individual lodes, from which his mean directions for the different "districts" were derived, was made many years since by Captain Charles Thomas in the following words—"Mr. W. Jory Henwood in his report of the two hundred mines in Cornwall and Devon has

2. The mean directions of cross-veins (cross-courses, flucans, guides, traverses, &c., mostly non-metalliferous) is in the

St Just district,*	26° N. of E.	Redruth, &c.,	35° S. of E.
St. Ives ,,	38° S. of E.	St. Agnes ..	51° S. of E.
Marazion ,,	41° S. of E.	St. Austell..	21 S. of E.
Gwinear, &c. ,,	47° S. of E.	Menheniot..	3° N. of E.
Helston ..	21° S. of E.	Caradon ..	77° S. of E.
Camborne, &c.	56° S. of E.	Callington..	43° S. of E.

Most of these directions correspond to notable joint systems in their respective districts, and many are at right angles or nearly so to other notable joint or vein-systems. Although they rarely contain ores of tin and copper, many have yielded considerable quantities of iron ores, and in many more, valuable local deposits of silver, cobalt, nickel, bismuth, uranium, and other rare ores have occurred. In a few instances—as at N. Poltimore in Devon, Wheal Sparnon near Redruth, and Woolf's cross-course in Breage, spangles of gold have been met with.

3. All the veins, whether metalliferous or not are apt to vary considerably in inclination (underlie), yet it may be stated in general terms that the cross-courses whether quartzose or yielding ores of iron or lead are steeper than the copper-veins,

given the bearing of nearly all the lodes which he inspected. He however took only the *general bearing* of the lode from one end of the mine to the other, overlooking the variations between the productive and unproductive parts. By this omission he not only lost a fine opportunity of accumulating many important facts, but the whole subject of *bearings* by his mode of statement has a direct tendency to mislead. Taking his report as a guide, the bearings would be no indication whatever of productiveness or otherwise; his rich lodes as well as poor being found under almost every variation of direction. In reference to the *productive* parts of lodes there is no such confusion,—order is all but universal—exceptions if any, are rare indeed, and then of limited extent." (Chas. Thomas, Remarks on the Geology of Cornwall, &c. Lecture 2, 1859).

It is I hope needless for me to say that I do not call attention to this criticism by a very eminent practical authority with any idea of diminishing the lustre of our former President's labours—and after all the mean direction of a lode as a whole *is* a matter of scientific importance; but I would take this opportunity to point out how very important is this question of the bearing of "rich parts" in a lode, and to urge practical men who alone can make the numerous necessary observations to do so on all possible occasions.

**Ibid*, XXVIII.

the copper-veins steeper than the tin-veins, and all the metalliferous veins steeper than the clayey slides. Perhaps the averages may be stated as under:

Cross-courses, &c.,	80°	from the	horizontal.
Copper-veins,	70°	,,	,,
Tin-veins,	60°	,,	,,
Slides,	45°	,,	,,

In the case of the tin-lodes there are, however, many very notable exceptions to the average stated above. Thus, the great Flat lode to the south of Carn Brea Hill, the lode at Wheal Kitty, Wheal Jane pyritous lodes, and many others have inclinations of less than 40° from the horizontal.

4. Of the mean width of the lodes, Mr. Henwood says:*

Those which yield (or have yielded) the ores of tin and copper, average	4·7 feet
Those which yield tin ore only	3·0 ,,
Those which yield copper ore only	2·9 ,,
Lodes generally in granite	3·1 ,,
,, in slate	3·7 ,,
,, at less than 100 fathoms deep..	3·9 ,,
,, at more than ,, ..	3·3 ,,
Cross-courses in granite	4·9 ,,
,, slate	3·5 ,,
,, at less than 100 fathoms ..	4·0 ,,
,, at more ,, ..	4.4 ,,

It thus appears (*a*) that tin lodes are wider than copper lodes, which is what we might expect from the common occurrence of workable tin capel and the rarity of copper capel.

(*b*). Lodes of tin and copper are wider than those of either separately, which also we might expect, because it would appear in many cases at least that the copper has been deposited in a re-opened fissure previously containing tin.

(*c*) The lodes are narrower than the cross-courses: a reason for this may be suggested hereafter.

As to the mean width of lodes in depth—as compared with their shallower portions—I would observe that the figures which might now be obtained would probably differ considerably from

* *Ibid*, pp. xv, xxviii.

those given by Henwood. If we were to limit our measurements to what are known as lodes in the old scientific sense, *viz.*, the actual fissure filling, the mean width would probably be much less for tin than for copper, since in general fissures are apt to become narrower in depth for mechanical reasons, and most of our deepest lodes now yield tin only, while nearer the surface they yielded copper. On the other hand if we were to include the workable portion of a vein whether it be lode-filling or impregnated and mineralized wall, the mean width of tin veins would come out much greater because, 1st, copper ores are rarely so much disseminated as tin ores, and 2nd, if they were so, they would not be workable lodes since they would not pay for working.

For other important general characters of lodes given by Mr. Henwood, I must refer to his published works, those cited above will suffice for my present purpose.

SPECIAL EXAMPLES OF "LODES."

I now proceed to describe two of the more notable lodes in the West of England, *viz.*, the great Dolcoath main lode yielding ores of copper and tin, and situated in the immediate neighbourhood of the junction of granite and killas on the north side of Carn Brea, and the still larger, though hitherto far less valuable Perran main lode situated at a considerable distance from the granite, and yielding chiefly iron and blende with a little copper and lead. In these two lodes we shall find illustrations of nearly all the phenomena of the lodes of the West of England—the "gozzans," "leaders," and "capels;" the "combed" and brecciated structures; concretions; "vughs;" mineral springs and recent chemical deposits.

(*b*) *Dolcoath Main Lode.* I select this lode partly for its great importance and partly because its history is better known than that of any other important lode in the West of England. It is a great copper and tin lode, which has its outcrop in the slate on the north side of Carn Brea Hill and passes downwards into the granite, which rock is entered at depths varying from 80 to 120 fathoms from surface. It has been worked on at intervals for a total length of 2¼ miles, the greatest depth of the workings is little short of 3000 feet, and it now yields nearly one-third of the total tin raised in the West of England.

The most westerly workings are at Camborne Vean, where the lode still proceeding to the westward enters hard ground and is lost in a series of strings. Proceeding towards the east the next workings are at Stray Park (now part of Dolcoath), then the workings of Dolcoath proper, followed successively by Cook's Kitchen, Tincroft (where it is known as Highburrow lode), and Carn Brea, which is the most easterly mine on the lode.

My sketch of the leading characters of this great lode must be merely a summary—the details of which must be filled in by those who wish to pursue the subject by reference to the works of Pryce,* Henwood,† Delabeche,‡ Capt. Charles Thomas,‖ Capt. Josiah Thomas.§ R. J. Frecheville¶—and above all by a careful study of the reports and plans issued from time to the shareholders of the respective mines. In what follows reference is principally made to that part of the lode which is situated within the Dolcoath sett—only specially referring to the other mines as occasion may arise.

The bearing of the lode as a whole is not far from N.E., that of the rich parts for copper above the 160 fathom level between E.N.E. and East. The dip or underlie is southward, in the upper part of the mine about 2 feet and in the lower part 4 feet in the fathom. At the surface was a fine gozzan from 3 to 6 feet wide, extending down to the adit level, which is about 28 fathoms below the surface; this gozzan in places contained a good deal of tin. From the adit to the 100 fathom level it was moderately, and to the 160 very rich, for copper. Between the 160 and 190 copper and tin occurred together. From the 190 fathom level to the present bottom of the mine, 410 fathoms below adit, the mine has yielded tin only—the lower levels in the tinny portions being on the whole much richer than those yielding ores of copper. The productive portions of the lode have been usually from 10 to 20 feet wide in the tinny parts, and from 8 to 18 feet in the coppery parts.

* Pryce, *Mineralogia Cornubiensis*, Bullen Garden, &c.

† Henwood, *Trans. Roy. Geol. Soc. Corn.*, V.

‡ Report on the Geology of Cornwall and Devon.

‖ Remarks on the Geology of Cornwall and Devon, 1859.

§ Journ. *Roy. Inst. of Corn.*, 1870. Report Min. Assoc., 1882.

¶ *Trans. Roy. Geol. Soc*, Corn., x, p. 146.

The passage of the lode from the killas to the granite occurred between the 80 and 120 fathom levels, and the lode became more horizontal and thinner. Its dip lessened successively to 68°, 57°, and 50°, and its size was reduced to 24 inches; and finally, in the hard granite between the 170 and 190 fathom levels to 12 inches.* This poor zone discouraged the owners, and, together with the low price of copper occasioned by the great discovery of copper ores at Parys Mountain in Anglesea, led to the abandonment of the deepest workings, and finally of the mine itself, which up to that time had yielded copper ores to the value of 2 millions, a large part of which was profit. At length, through the energy of Capt. Chas. Thomas, the father of the present manager, the mine was re-opened about the year 1846, a sum of £3,084 being locally subscribed for that purpose. The pumps which had been drawn up from the 210 to the 160 were dropped again, and the mine was drained to the bottom by the end of 1849. Sinking was resumed,† the junction of Harriett's lode with the main lode at the 180 was explored, dividends were resumed in 1853, the south lode fell in at the 364, and that which had been one of the richest copper mines became the most productive tin mine in Cornwall, so beginning a new era for tin mining in the West of England.

From the 190 downwards the size of the lode increased, and at 220 it was at least 10 feet thick. In 1858 the tin began to "make" in the granite, the lode being from 20 to 26 feet wide. In January, 1873 they began to drive the 314 fathom level; in 1874 the lode had "a very fine appearance;" in 1882 a depth of 376 was reached, and the present depth of the sump (March, 1892) is 422 fathoms.

The total length of shafts and levels on the lode had in 1882 reached 138 miles, of which one half were in Dolcoath alone. At the present time the total cannot be less than 160 miles.

* The corresponding poor zone in Carn Brea Mine extended downwards to the 238 fathom level.

† From 1800 to 1849 only 55 fathoms had been sunk, or but little over one fathom a year. From 1849 to 1892 over 200 fathoms have been sunk, or about 5 fathoms per year.

The other mines on this great lode now reached depths as follows:—Cook's Kitchen, 400 fathoms; Tincroft, 300 fathoms; Carn Brea, 312* fathoms.

The mining cost which includes cost of management, water charges (pumping), winding, dead-work, development, supplies, new erections and wear and tear, amounts to about 15/6 per ton, the dressing cost is about 4/-, or together about 19/6. The actual cost of breaking the ore in 1870 was, in Dolcoath 5/6 per ton, which sum included winding and tramming. The cost of driving a level 6 feet wide and 8 feet high was £20 per fathom.

The production of the four mines for the 10 years from 1872-81 was 32,430 tons of tin ore, 6,692 of copper ore (nearly all of this from Carn Brea Mine), and 1,901 tons of arsenic. This production has been largely increased during the succeeding decade, Carn Brea having especially improved. In 1890 the produce of tin ore was as follows:

Dolcoath	.. ..	2023 tons.
Cook's Kitchen	..	206 ,,
Tincroft	.. ..	894 ,,
Carn Brea	.. ..	1671 ,,
	Total	4794 ,,

or considerably over $\frac{3}{10}$ths of the total production of the West of England.†

The total value of the produce of Dolcoath Mine alone has probably been not less than ten millions sterling, the details of the estimates being as follows:

* The following particulars of the working cost on these four mines as given by Mr. R. J. Frecheville (*Trans. Roy. Geol. Soc. Corn.*, x, 146, 1882) will be read with interest. There is probably but little difference since the date of the paper except that the yield at Carn Brea has greatly improved.

1872-81.	Average yield. lbs. per ton.	Mining cost.	Dressing cost.	Total cost. per ton.
Dolcoath ...	59 ...	16 11 ...	3 10½ ...	1 0 9½
Cook's Kitchen	43 ...	16 4½ ...	4 5½ ...	1 0 10
Tincroft ...	53 ...	13 9 ...	4 8 ...	0 18 5
Carn Brea ...	35 ...	14 3 ...	3 9 ...	0 18 0

†The "calls" from the three eastern mines—no calls having been made at Dolcoath—amounted to £56,950 during the period 1872-81, the produce of the four mines realized about £1,750,000, and the dividends amounted to £277,226. From 1882 to 1891 the dividends have been nearly £400,000 and the calls less than £100,000, Dolcoath having made no call during the entire period.

Early workings on the various lodes, estimated at	£500,000
Produce of first great working previous to letting in the water in 1778, estimated by Capt. Chas. Thomas	£2,000,000
Produce from re-opening in 1800 to 1870 according to Capt. Josiah Thomas ..	£5,500,000
Produce 1870 to 1890, estimated at ..	£2,000,000
	£10,000,000

Of course this 10 millions has not all come from the great lode,—a considerable portion was yielded by the caunter lode, Harriett's lode, and others; but if we allow the liberal amount of two millions for these there still remain 8 millions as the produce of a length of 550 fathoms on the main lode,—with perhaps an *average* depth of 350 fathoms,—or say £40 per square fathom of lode (one fathom in height and length and the width of the lode).

The lode however has been worked on more or less for a total length of at least 1800 fathoms, and, excluding the 550 fathoms in Dolcoath, to an average depth of perhaps 250 fathoms; we have therefore about 312,500 square fathoms of lode worked or explored in the other mines for which we can hardly assume the produce in tin and copper at a less value than 5 millions sterling, giving for the whole lode to the present average depth of less than 300 fathoms, a produce of 13 millions sterling, or over £25 per square fathom of lode.*

The average width of the lode is certainly much greater than the average of the lodes of tin and copper in the West of England as given by Mr. Henwood. From the 66 to the 197 in Dolcoath it was about 6 feet, but narrowing in places to 1 foot and widening in others to 16 feet. At the present bottom of the mine it varies between 2 to 4 fathoms, with perhaps 16 feet for an average; the tinny portions being mostly wider than those containing only copper as already stated. In Cook's Kitchen, Tincroft, and Carn Brea mines the present average is somewhat

*Of this large amount perhaps about 4 millions have been yielded by copper ores and 9 millions by tin ores, equal to 570,000 tons of copper ores at £7, and 170,000 tons of black tin at £53, which are pretty near the average prices realised.

less. On the whole I think we may safely take the mean width of the whole lode at 6 feet for the coppery portions and 10 feet for those yielding tin (of which the leader or actual fissure filling will not average more than one foot) for the whole period since the mines have yielded tin, but occasionally running up to 6 feet as in the great bunch recently worked at the 280 in Carn Brea.

The walls in the great lode are generally fairly distinct, but less so in depth than nearer "grass." The hanging wall is generally better defined than the footwall—especially in the deeper workings. Vughs and cavities were much more common in the lode in the shallower than they are in the deeper workings, but they are still occasionally met with in all the mines on the lode.*

The contents of the lode have as already stated varied at different depths. In the shallower portions above adit there was much gozzan, consisting of earthy brown iron ore with iron pyrites and spongy quartz, and in places earthy black copper ore, with various rare crystallized arseniates and phosphates of iron and copper, also much chalcopyrite and chalcocite. In the eastern part of the mine a good deal of tin was raised from the shallower workings. Some of the earthy brown iron ore was found as far down as the 197 fathom level. The rich parts while yielding copper usually gave it as chalcopyrite with few crystals. Soon after reaching the granite most of the copper gave out and the mine changed to a tin mine. The richest ores of tin are of a bluish colour, not very hard but quite compact, and permeated in all directions by strings of rather light-coloured oxide of tin. Often this bluish rock passes into a dark red ferruginous mass without becoming poorer in tin. Careful microscopic examination shows that the blue tin-stone, apart from the tin, consists of quartz, chlorite, and schorl--the latter mostly in minute needles; and the change from blue to red seems to be a

*In November, 1814, a cavern was discovered in the main lode at a depth of 170 fathoms. It was from 18 to 20 fathoms long, 3 fathoms high, and from 4 to 9 fathoms wide. It contained much loose material which had fallen from the sides and communicated by narrow channels with many subsidiary cavities.—*See Trans. Roy. Geol. Soc. Corn.*, Vol. 1. Similar vughs have been found in nearly all the master lodes of the West of England.

subsequent oxidation change of the chloritic portion of the mass.* The poorer parts of the lode are very similar, except that they are very much harder and more siliceous, and with a tendency to a black colour.

The country rock changes noticeably with the lode matter. The killas is fairly soft near the surface; it generally becomes harder as it approaches the granite, but is always soft near the rich parts of the lode; above it is often yellow or buff in colour, below mostly deep blue. While the granite remained very hard the lode was not productive either for tin or copper—it is now in general fairly soft and moist, the felspar much kaolinized and often accompanied with pyrites and red oxide of iron.

The curious alternations of killas and granite which this great lode cuts through have been noticed by many writers. In 1882 "a large mass of hard slaty rock was met with in the 352 fathom level east of the new eastern shaft....included in the granite 240 fathoms below the point where that rock was first cut into by the workings....this resembles the ordinary killas of the district, and on comparing thin sections of the two under the microscope their identity becomes at once apparent."†

The imagination is struck with the figures expressing the extent and the produce of this great lode. But if we look at the facts in another way, as suggested by M. Moissenet, we shall see how insignificant a feature it forms in the earth's crust. Let us suppose a model of the lode made to a scale of one thousandth the real size—it could be easily made from a sheet of lead 12-feet long and 3-feet wide. In many places the thickness would have to be reduced to a mere film, but in some it would require to be thickened up to a quarter of an inch or a little more. The sheet might be placed on edge—its length in a direction nearly N.E., S.W., and with a considerable dip to the southward. If now it were bent lengthwise in such a way that the thicker portions were more nearly E.W. and the thinner more N.E., S.W., and also bent in width so that the thicker portions stand more nearly vertical than the thinner, and the lower portions more nearly horizontal than the upper; it would very fairly represent the relative proportions of the lode and

*See Cornish Tin-stones and Tin-Capels, pl. IV, figs. 3-4.
† Phillips, Ore deposits, pp. 181-2.

also its position in the ground.† Viewed in this manner the vast and richly-filled subterranean channels, which by the implements of the miner are transformed into caverns of imposing extent, appear what they are—as thin veins in the ground.

(*c*) *The Perran iron lode.* This great lode is referred to by Borlase, who wrote in 1758, and was briefly noticed by Sir H. Delabeche in 1839,* and by Mr. Henwood in 1843.† Later it has been described in more or less detail by Smyth,‡ Bryant,§ and myself ||

The Perran lode bears about 35° S. of E., and underlies from 3 to 4 feet in a fathom to the south-west; and is altogether in killas except where it crosses an elvan. Its western exposure in the cliff at Gravel Hill, at the northern extremity of Perran Bay, is very wide, consisting of two branches divided by a horse of killas. It consists here principally of somewhat siliceous brown hematite, earthy carbonate of iron with traces of lead, and blende associated with garnet; and was a few years ago worked rather extensively above the adit level by a long adit and by two shafts from above, besides some extensive surface pits. From here it may be traced inland for a distance of four miles to Deerpark, where it takes a turn—at first directly east, afterwards some degrees N. of East, and so proceeding in a curve for several miles more. It is however of little value so far as is yet known after the first four miles, and the following remarks will relate solely to this portion.

To the eastward of the Gravel Hill Mine, formerly known as Penhale Iron Mine, is the Halwyn Sett, where also a shaft has proved the lode a good many fathoms down—20 or more. Next come the rather extensive and irregular open works on the brown hematite and carbonate of iron of the Mount Mine,—then the great open works at Treamble,—after that the extensive and

† The actual fissure or leader, apart from its metalliferous capels might be represented on the above mentioned scale by a sheet of paper thickly or thinly coated with lead on each side in accordance with the dimensions given above.

* Report on Cornwall, &c., p. 618.

† *Trans. Roy. Geol. Soc. Corn.*, V, p. 108.

‡ *Trans. Roy. Geol. Soc. Corn.*, VII, p. 332 (1858), and X, p. 120 (1882).

§ *Rep. Roy. Corn. Polytech. Soc.*, 1871, p. 98.

|| *Rep. Miners Assoc.* 1873.

irregular works at Great Retallack—followed by the Duchy Peru Mine with its several shafts—and still further east by the trial pits at Deerpark and Penhallow Moor.

Each of the great Treamble excavations is crossed by a very promising lode of "silver lead,"—the lodes No. 1 and 2 of the Great Retallack Mine adjoining to the north and east. Nothing has been done to develop these lodes for many years, but in working the iron ore of the outcrop some 60 or 70 tons of lead ore were obtained which contained from 15 to 30 ounces of silver per ton as sold without dressing. The iron lode in the lower or western quarry was in 1873 proved to a depth of 17 fathoms by an underlie shaft, and found to improve in quality as it went down. In the upper quarry the lode splits into several branches, the largest going away to the north of east towards the old workings in Great Retallack, the others proceeding south of east to Berriman's shaft, which was also sunk to a depth of 17 fathoms. Somewhat later other shafts were commenced in each of the quarries, also a vertical shaft at a point between the quarries, but about 40 fathoms to the southward; but this intended "main shaft" was, I believe, abandoned before it reached the lode.

A little west of the No. 1 lead lode just mentioned is a deposit of unctuous black flucan—much resembling graphite—which in 1873 I found to contain from 3 to 5 per cent. of free carbon.

At Great Retallack the lode is several fathoms wide, yielding near the surface brown hematite and blende, the blende increasing on the whole in depth; in some months 500 tons of blende have been raised and sold, and the total output must have been many thousands of tons. Many concretionary masses of iron ore were found, some hollow and full of water. Some lead ore, very rich in silver, has also been raised from this mine at the intersection of the Peru lode, and spots of copper have been seen at times.* In 1860-61, large quantities of blende were raised and sold, but at very low prices, from October to June in the latter year the sales where nearly 5,000 tons. Considerable quantities were raised for the next few years, and the shaft was

*Mining Journal. The Perranzabuloe districts, July 27, 1861.

sunk below the 60 where good yellow copper ore made its appearance; but discouraged by the low prevailing prices, the water being "very quick" was let in, and work was for the time confined to the adit level, and subsequently to sinking in other places where there was not much water to contend with. The lode was said to be "240-feet wide."* It was undoubtedly very wide as I can testify, but this great apparent width was no doubt due to its lying very "flat" in that part.

At Duchy Peru, just east of Great Retallack, the "old workings" have been carried to a depth of 50 fathoms on the N.S. lead-copper lode—the "Peru lode," celebrated for the richness of the silver specimens it has yielded.† The workings on the iron lode before the mines were re-opened‡ about 1871, had been carried down between 20 and 30 fathoms, and this depth was increased to 40 fathoms by March, 1873.

Roebuck's shaft is vertical, 12-ft. by 7-ft., fitted with ladder-ways and containing a column of 18″ pumps.§ By the year 1881, it had been carried down to the 70 fathom level; since then, I believe, no further sinking has been done, and at the present time not only Duchy Peru but practically all the mines on the great lode are idle.

The killas country about the great lode at Duchy Peru seems to be much disturbed. South of the lode it is hard and appears to dip towards it, but near the lode it is soft and dips with it, as shewn in the sketch (fig. 9, Plate VIII), just as is common in the case of faults in yielding strata. Eastward from Duchy Peru is Deerpark mine, from which considerable quantities of iron

* *Ibid.*

†It was only a few inches wide, but it yielded silver-lead of great richness, some parcels containing as much as 2000 ounces to the ton of ore, a part of the silver being "native."

‡By the Cornish Consolidated Iron Mines Corporation.

§The condition of the mine in the middle of 1873 was described in detail in the paper by the present writer already referred to, as also the condition of the remarkable hot "end" at the 20 fathom level east of Vallance's shaft. The temperature in October, 1873, was 124° F., at surface 64° F. This high temperature was attributed to the oxidation of pyrites—and the same cause was in 1881 assigned for the high temperature in the 60 fathom cross-cut north—which however was only 82° F. against a surface temperature of 52° on the 26th October, 1881.

ore have been raised. Beyond Deerpark the outcrop is seen in Penhallow Moor and apparently much farther, but no important openings have been made upon it.

The general characteristics of the great lode appear to be somewhat as follows. It occupies a very distinct and unusually wide fissure which cuts through the stratified rocks, and also through several intrusive dykes of elvan. The upper portion underlies somewhat more—the deeper workings, so far as yet seen, somewhat less than 45° to the southward. The width of the fissure and of its contents varies greatly, occasionally a few inches, or even less, very frequently from 3 or 4 up to 20 feet, occasionally as much as 40 or 50 feet, and perhaps more.* The upper portion is essentially a "gozzan" of compact or cellular brown hematite, sometimes containing kernels of chalybite,—at times there is very little quartz, at others the whole mass is highly siliceous. Beneath the brown hematite—sometimes only a few fathoms from surface—and always before the sea level is reached, the lode appears to be largely composed of spathose carbonate of iron (with occasional broad belts of dark compact blende, and much more rarely veinlets of yellow copper ore) or of galena. On the whole the carbonate of iron is most abundant in the foot-wall, the blende in the central or upper parts.

In the wider portions of the lode the filling is a mass of breccia, enclosing large masses of carbonate of iron and of blende, and Mr. Smyth in 1881 gave sketches of two of the deeper workings shewing this mode of occurrence. Thus near the hot cross-cut at the 60 referred to in the foregoing note, the lode lies very flat, and consists of (*a*) a broad band of white clayey carbonate of iron on the foot-wall, this is succeeded by (*b*) a mass of mixed iron pyrites and flucan, (*c*) a thick mass of the breccia referred to, containing especially in its upper portions large lumps of dark blende. In other parts bands of red and brown or black iron oxides and of quartz vein-stone are frequent, —the black oxide containing zinc and manganese with sometimes copper,—in fact manganese is present almost everywhere.

*The widths sometimes stated of 100 feet or even more are *horizontal* sections across an *inclined* lode, and therefore misleading.

A marked feature of this lode is the fact that numerous quite narrow cross-veins cut across the ore-shoots and heave them, or even abruptly terminate them. as, in the absence of extensive explorations, would seem to be the case. This lode has evidently been most imperfectly opened up, partly on account of its very size—necessitating large capital to properly work it—partly because of the very fluctuating character of the demand for iron ore. Mr. Smyth's estimate of the total output of iron ore up to 1880 was "something more than 150,000 tons," but this is based (*a*) on his estimate of the extent of the workings in 1858, and (*b*) on the quantities recorded in Mr. Hunt's Mineral Statistics. As to the first part I can say nothing, but as to the second, it must be remembered that Mr. Hunt's figures were obtained by voluntary assistance only, and in the case of iron ore were always known to be defective. My own estimate* was that 200,000 tons had been extracted up to that period. Since then the output has been small, probably not more in all than 10,000 tons.

Of blende it is hard to say how much has been raised, though the output in the case of Great Retallack has been occasionally as much as 500, and in Duchy Peru 900 tons per month; on the whole it is not likely that the lode has yielded in all less than 20,000 tons of blende, besides small quantities of rich silver-lead and copper. These are small quantities for so large a lode, and in fact great as the lode is, most miners would rather look upon it as the great gozzan indicator of some exceedingly rich copper vein existing at a greater depth than as a lode valuable in itself for either iron or blende.

(*d*) *Special characters of lodes.* The Dolcoath main lode and the Perran iron lode afford illustrations of most of the characteristic phenomena of the West of England fissure-veins, such as fissures traversing indiscriminately or passing at times between different kinds of rock, with their intersections and heaves by caunters or cross-courses; good and bad directions; rich and poor parts; contact deposits; gozzans and pseudomorphs; capels and flucans; breccias and concretionary structures; combed structures and

*Made in 1873, when I was consulting engineer to the company then working, and so had opportunities of knowing the extent of the excavations.

vughs; mineral springs; local chemical action; extensive local alterations of lode-substance and country rock and the like. Some of these phenomena have been already referred to with sufficient detail, of others which have been developed in a more marked manner in other localities, it may be well here to give references to some select examples.

"Contact deposits," that is rich parts of the lode bounded by different rocks on the hanging and foot-walls, though existing in places, are not particularly noticeable either in Dolcoath or Perran lodes. The great flat lode however on the other side of the Carn Brea range affords notable examples in most of the mines (see fig. 10, Plate III), so also many of the copper-lodes in the Gwennap district which frequently had their rich parts bounded on one side by killas and on the other by elvan. Similar contact deposits having slate on the hanging wall and granite on the foot-wall are common in the copper lodes of the Caradon district.*

"Intersections" and their remarkable effects on the lode are particularly noticeable in the Perran lode, as already mentioned; there are many too of much importance in connexion with the Dolcoath lode, while many of them are accompanied by notable heaves—as in the case of the great cross-course between Dolcoath and Cook's Kitchen, which heaves the lode many fathoms to the right. The most remarkable, if not individually the most extensive examples of heaves, however, are perhaps those of the St. Agnes district, where they have been most carefully and accurately described by several observers—and notably by Mr. A. T. Davies in 1879.† Further reference to this part of the subject will be made in the fifth chapter.

The "good and bad directions" of the rich and poor parts of the copper-bearing parts of Dolcoath have been already referred to in quotations from lectures by Capt. Chas. Thomas. Similar phenomena were very marked in most of the Gwennap copper mines—they are traceable but not so marked in many of the tin mines.

* See Foster, Great Flat Lode, *Quart. Journ. Geol. Soc.*, XXXIV, p. 640, 1878, and Henwood, *Trans. Roy. Geol. Soc. Corn.*, VIII.

†On heaves and faults. Rep. Miners Assoc. 1879.

"Gozzans" occur in connexion with a majority of the main lodes in the killas, and in some of the lodes in granite. The finest examples known have been on the "backs" of copper lodes, extending in some instances—as at the United Mines in Gwennap, and Wheal Friendship near Tavistock—to a depth of 90 fathoms or even more, if the permanent water-level of the country is so far beneath the surface. Many of the rarer forms of phosphate and arseniate of copper, and an immense number of other rare minerals, have only been found in the gozzany parts of copper lodes. The changes of iron pyrites and of carbonate of iron into gozzan are obvious in innumerable instances. The manner in which these changes have been brought about will be considered hereafter in a future section.

"Pseudomorphs" of one mineral in the form of another have been frequent in both the lodes while shallow. Such pseudomorphs are very rare in the deeper parts of the Dolcoath lode, though they have often been found at depths of 200 fathoms and upwards in East Pool, the Gwennap mines, South Caradon, &c. Still, speaking generally, it may be said that they are far rarer in deep than in shallow mines.

"Capels" are the silicified walls of the fissures, they occur more especially in tin mines and often indeed contain enough tin to pay for working, but they are known also in lodes yielding copper, lead, zinc, and iron. Besides those characteristic of the Dolcoath lode, very fine examples occur at Wheal Uny and other mines on the great flat lode.* Their peculiarities will be described in some detail hereafter, when the method of their formation comes to be discussed.

The "combed structure" frequently exhibited by the lead, copper, zinc, and iron lodes of the West of England, and to a less extent by the tin lodes, is a development of successive plates of vein-stone,—or in the rich parts of mixed ore and vein-stone,—the latter being usually highly crystalline. In its simplest form this structure consists of a fissure lined with crystals on each side, having their bases on the walls and their apices directed towards the centre. In some cases the fissure is thus altogether filled up with two sets of crystals meeting in the centre—in others there

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*See Foster. "Great Flat Lode," *loc. cit.*

are many such layers, some being less distinctly crystalline than others—or even apparently compact until examined microscopically. Such examples are very common in copper veins in the Gwennap district. Many have been cited by Delabeche and Henwood, and a very remarkable case was figured by me in 1873.*

In lead veins fine examples have occurred at Wheal Rose and Wheal Penrose near Helston, and in iron lodes at Restormel near Lostwithiel,† and at Pawton near St. Columb.‡ The evidence afforded by combed structure as to the successive re-openings of fissures, and as to changes in the character of the underground circulation, will be discussed in a future chapter.

"Vughs" are incompletely filled spaces in fissure lodes, usually lined with well crystallized vein-stones, and commonly associated with combed structure in the vein. Both the lodes described have afforded fine examples; in the case of Dolcoath an unusually large one was described by Mr. John Rule in 1818.§

"Flucan" seems to be partly a result of chemical changes in the lode-filling or in the adjacent country rock, partly a deposit from circulating water, and partly the result of a grinding produced by the motion of the walls of the fissure on each other. It is abundant in certain parts of both the Dolcoath and Perran lodes.

"Brecciated structure" is comparatively rare at Dolcoath—extremely common at Perran. A fine example of this structure in a lead lode is that at Wheal Mary Ann, described by Dr. C. Le Neve Foster.‖

"Concretionary structure" is also very common in the Perran lode—notably in the Great Retallack portion. Fine examples at Relistian and at New Rosewarne are described by Mr. Henwood¶ and Dr. Foster.*

Proc. Inst. Mech. Eng., Cornwall Meeting, 1873, pl. 36.

†See *Moissenet Lodes of Cornwall*, p. 85, note.

‡Report Miners Assoc., 1875, p. 26.

§ *Trans. Roy. Geol. Soc. Corn.*, 1, p. 225.

‖*Trans. Roy. Geol. Soc. Corn.*, IX, p. 155.

¶*Trans. Roy. Geol. Soc. Corn.*, V.

**Rep. Miners Assoc.*, 1866.

"Mineral Springs" have been observed in the Dolcoath lode, but their characters have not been of any specially interesting nature. The remarkable springs in the lode at Wheal Seton a little to the north of the Dolcoath lode, and at Wheal Clifford a few miles to the east, have been noted and described by several writers, and particularly by Mr. J. A. Phillips. These will be further referred to in a future chapter.

"Local Chemical action," as occurring in the Perran lode, has been already referred to. Similar action was formerly very evident in many parts of Wheal Clifford in Gwennap. Further reference will be made to this subject hereafter in connexion with the theories of lode formation and of local metamorphism.

SEC. 6.—*The mutual relations of ore deposits and of country rocks.*

Many observations on this subject have been made by previous writers on the phenomena of the West of England ore-deposits. In summarizing them in the present section, I shall endeavour to add illustrations as may be necessary by reference to specific examples.

The following generalizations are almost universally accepted.

1.—Junctions of unlike rocks, and especially of eruptive with stratified rocks (or proximity to such junctions) are regarded as favourable conditions, the reverse as unfavourable.* Notable illustrations of this statement are afforded by the Great Flat Lode and the Caradon lodes, which are frequently bounded on one side by granite and on the other by killas. A great many examples of copper lodes locally enriched by proximity to elvan courses are mentioned by Mr. Henwood, and also by Messrs. Barnett and Argall.†

2.—Valuable deposits of tin and copper occur in both eruptive and stratified rocks, but only in or near eruptive rocks of the acidic type; while valuable ores of lead, antimony, and manganese only occur in stratified rocks, though usually in proximity to basic eruptive rocks.

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*Mr. Chas. Thomas has recently stated this in axiomatic form for a certain class of junctions:—"The junctions of granite and killas invariably (*i.e.* in the West of England) exert a powerful influence for good on all metalliferous lodes." --(Proc. Mining Assoc. and Inst. Corn., 1883. p. 394.

† On the Elvan Courses of Cornwall.—Report Miners Association, 1874,

3.—The character of the vein filling varies notably with the nature of the country, as may be seen in the case of fissures which pass through two or more kinds of rock. At Dolcoath the lode was good for copper while in the soft killas of moderate depths, but when it got into the harder killas near the granite it was much poorer. At the 110 fathom level below the adit it struck a trough of granite and began to yield tin, but was not rich until Harriett's and the south lode fell in, the granite then got softer and the lode wider and richer.*

The Wheal Vor tin lodes are rich only while in the killas, but die away or are entirely barren on entering the granite on either side of the killas "trough." On the other hand the tin lodes at Great Work, only a couple of miles away, are rich only while in the granite and of very little value after entering the killas.

Similar examples in connexion with copper are afforded by the Gwennap district. At Tresavean the lodes, and especially the great lode, were worthless in the killas and of enormous value in the granite. On the other hand the nearly parallel lodes of the Consolidated and the United Mines in the same parish were rich only in the killas and became worthless in the granite. East Pool in the Camborne district was a notable example of such change, for the main lode changed from rich copper to rich tin in five fathoms, in passing from killas to granite.

Another very striking example is afforded by "Woolf's cross-course in the Breage district. In the southern part of its course near Porthleven, it yields lead at Wheal Rose—going northward it is barren, containing only quartz and clay, in passing through the Wheal Vor district which consists of a different kind of killas—but still farther to the north in the Godolphin mines, where the rock changes again, it yielded very large quantities of grey and yellow copper ores. Still another example is afforded by the main tin lode of the Charlestown mines near St. Austell, which in its western extension in the granite and in the much altered "killas" yields only iron, while farther east where it enters the fossiliferous Crinnis shales it yields copper.

*Josiah Thomas' Report Miners Association, 1882.

This generalization is accepted in other countries, thus in Norway the Kongsberg silver lodes are only valuable where they traverse the fahlbands, and in Australia the auriferous quartz lodes of the Gympie district are only of value while passing through the black slate.

This relation of mineral contents to enclosing rock is even observable on a microscopic scale, thus Dr. Wadsworth says "It is not uncommon to find minute veins in rocks, which under the microscope shew variations in their filling material as they pass through different minerals.* The bearing of these observations on the theory of lateral secretion will be considered hereafter.

4.—Lodes of tin or copper in killas dipping towards or into a great mass of granite or elvan are usually richer than similar lodes dipping away from such masses. The Dolcoath main lode and the lode at Wheal Eliza are good examples of the value of this character.

5.—Lodes, and especially the rich parts of lodes, are usually bounded by rocks exhibiting notable alteration phenomena, in other words, valuable metalliferous deposits are rarely if ever found in highly crystalline rocks, whether stratified or eruptive, which present little or no evidence of secondary change. The changes are, in some instances, merely alterations of structure, but in most cases there are also extensive chemical alterations.

The most notable structural alteration is the development of a tabular or "sheeted" structure in the country rock by means of a series of joint-planes parallel to the walls of the vein. Similar planes are sometimes also observable in the vein substance. This sheeted structure must not be confounded with foliation, lamination, quarry cleavage, or slaty cleavage (strain-slip-cleavage), all of which aid in the division of rock masses into tabular fragments, that is into fragments having two dimensions much greater than the third. These are due to causes which are essentially independent of the metalliferous deposits with which they are associated, although their pre-existence may have acted favourably by facilitating the produc-

* Proc. Boston Soc. Nat. His., May, 1884.

tion of useful cavities to be subsequently filled with metalliferous matter.* Sheeted structure in veins must also be distinguished from combed structure, which is altogether a phenomenon of deposit. In connexion with true sheeted structure there may be traced the following gradation.

(*a*). An ordinary fissure vein-filling in a fairly compact rock. Of this condition nearly all the lodes afford examples in some part of their course.

(*b*). The same in a "sheeted" country rock. The following examples will serve as illustrations. At Wheal Metal in Breage, the principal (metal) lode runs a few degrees north of east (mag.) and underlies to the northward about two feet in a fathom. The killas is for the most part permeated with tourmaline (tourmaline-schist), and in some places highly silicified—and is almost horizontal—yet in very many places a kind of jointing exists by the side of the lode parallel to it, and therefore directly across the bedding, so forming a succession of false walls. Similar phenomena are common in a great many other veins traversing killas, both of tin and copper.

At the Ruby Iron Mine near St. Austell, a compact vein of red hematite traverses more or less altered granite, which frequently exhibits this sheeted structure for many feet on each side of the lode.

(*c*). A sheeted mineralized belt associated with one or more main veins.

Pednandrea and Great Wheal Fortune afford examples of this stage.

(*d*). A "sheeted" earthy or clayey vein-filling in a "sheeted" country rock.

Examples of this stage are also common in the tin and copper mines. In many instances it is quite impossible to say where the "lode" ends and the "country" begins, all being sheeted together, although no part of the lode is highly crystalline.

(*e*). A "sheeted" mineralized belt not associated with any main vein.

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* The origin of these four forms of tabular jointing has been dealt with sufficiently in Chap. 1, Sec. 2.

This last stage is illustrated by the phenomena of Minear Downs and Cligga, already described.

It will be seen hereafter that Mr. Fox's theory of the electrical origin of many ore-deposits has a direct bearing upon this question of sheeting.

In most cases, whether the sheeted structure be observable or not, there are other notable alteration phenomena of more distinct chemical origin—such as discoloration by oxidation or hydration; or bleaching by lixiviation; or softening by incipient decomposition; or hardening by infiltration of siliceous or schorlaceous matter; or general "mineralization" by the infiltration of pyrites or other metalliferous substance; so that in some way or other the approach to a good mineral deposit is always heralded by signs unmistakeable to eyes which are familiar with the mineral phenomena of that particular district. Unfortunately the indications vary to some extent in different districts, and often they extend to but very small distances from the ore-deposits sought; frequently they are disguised by more general surface decomposition, or buried beneath more recent and barren strata, or under surface accumulations of detritus or of vegetable soil; so that it needs in most cases not only great knowledge and experience, but also a large expenditure of time and money in prospecting and in exploration work before the valuable existent deposits are hit upon, unless some lucky accident comes to the aid of the miner.

The chemical changes in granites associated with metalliferous deposits are so very marked, that Capt. Chas. Thomas was in the habit of speaking of the unchanged granite (quarry granite as it is often called) as *primary* granite, while the changed rock looked upon as favourable by the miner he spoke of as *secondary* granite. Again our corresponding member, Mr. R. Pearce, writing on the metalliferous granites* of Carn Marth, remarked that the whole rock is commonly discoloured with peroxide of iron; and the felspar kaolinized, or else replaced by chlorite, fluor, schorl, or oxide of tin; while a tabular structure is often set up in the neighbourhood of ore-veins. In 1863 some

*Report Miners Association, 1862.

of his pupils, after a number of excursions to Carn Marth and other mining localities, wrote as follows :—

"The general character of the granite of the hill (Carn Marth) was 'primary,' or composed simply of quartz, felspar, and mica, but where a vein of quartz or veins of other characters were discovered, the felspar for 2 or 3 inches on each side was of a pinkish colour, and it sometimes contained chlorite; where the vein was larger the granite was altered for a still greater space on each side of it, apparently as if by the influence of the vein."

"This alteration of the granite was more plainly shewn at West Wheal Damsel. Here we found all the granite near the lode to be very much altered, more or less according to its proximity......the change being greatest near the lode; the felspar was sometimes entirely absent, chlorite occupying its place, sometimes only partially; and that broken at a still greater distance from the lode was merely of a flesh colour. In all our excursions we have noticed this alteration of the granite by the influence of lodes and veins, and in some cases a still further change from these influences was observed. At a burrow at old Wheal Jewell there are stones of granite to be found where the felspar has been replaced by tin and schorl (as at Dolcoath, &c.) In a cross-cut at East Wheal Damsel, at a distance of five or six fathoms from the lode, the granite contained cuprite."

A similar change occurred at the junction of the lode and elvan at the United Mines.* Mr. Pearce further observes that primary and secondary granite were not formed at different times or under different circumstances, but that the original granite was merely changed "by the influence of the lodes which pass through or near it, these various alterations being effected by the decomposition of the mineral constituents of the lodes and the solvent action of water.†

6.—It is sometimes said that very hard ground is unfavourable. In one sense this is always so, since it increases the cost of the underground operations, but in this sense very soft ground

Ibid, Notes of Excursions, read September 8, 1864.

†*Ibid*, Report for 1863.

is also unfavourable. The statement is however true apart from this consideration, except when the hardness is due to silicification and the production of schorl by the actual mineralizing circulation, as is often the case with tin deposits.

Since more or less of decomposition is a general phenomenon in the rocks adjoining important ore-deposits, while silicification or other impregnation-hardening apart from a definite deposit of vein-quartz is only occasional, and in fact limited practically in the West of England to tin deposits in killas,* it follows that lead, copper, manganese, antimony, &c. are rarely found in quantity in really hard strata, while even tin is often good where the rocks have not been hardened locally. I proceed to give some further specific illustrations of these statements.

Tin in killas stockworks is mostly in a killas which is not materially altered except by the production of white mica (Gilbertite), which accompanies the tin crystals occupying the joints. Occasionally there is a little blackening due to the production of schorl, and in a few instances crystals of quartz also occur. Of course the stanniferous killas as a whole is a greatly changed rock, but the final local change in the immediate neighbourhood of the little veins is usually not at all strongly marked. It is the stockwork as a whole which must be looked upon as the ore body, and the contact metamorphism in connexion with it is perhaps less than in any other instance known to the writer.

At Old Wheal Vor, at Wheal Metal, and generally in the Wheal Vor district, "when the rock is hard the lode produces well, while soft strata are not congenial for that mineral (*i.e.* tin ore) but often produce copper."†

The hardening in this neighbourhood is mostly silicification, a great deal of very fine (microscopic) schorl exists in the rocks, but not specially in immediate contact with the lodes.

In granite, tin is usually accompanied by a local softening, owing to the kaolinization of the felspar, although there is often too a still more local hardening by the production of quartz or schorl.

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* Siliceous infiltrations of the Silurian Strata in the Clogau district of N. Wales are always thought to be favourable for *gold*, while the soft beds are unfavourable. See A. Dean, Report Miners Association, 1865. Of course the association of gold with quartz is universally recognized.

†R. Hancock. Report M.A., 1870, p. 39.

At Trevenen Mine in the Carn Marth district, the lode is separated from the compact granite by pot granite (*i.e.* granite of which the felspar is changed to kaolin). At Wheal Dream in the Helston district, a shaft was put down, through hard ground to cut a shoot of tin which dipped away west from the old Trumpet Mine. On reaching the "lode" it was found to be barren until about the 60 fathom level, when the tin was reached "in a softer channel of ground." From this point to the 180 fathom level the mine was productive.* It would be easy to multiply instances of this general softening. In elvans the rock is often softened from the kaolinization of the felspar but hardened by silicification.

Copper. In slate, softish strata are considered favourable, especially if light yellow, brown or red. Hard dark blue slate is always regarded as an unfavourable sign, so too is a hard siliceous elvan or hard granite. In fact silicification cannot be regared as favourable to the production of deposits of copper, except very locally and in very special cases.†

The special relations of gozzans to deposits of copper ore will be dealt with hereafter.

Lead. At West Chiverton the "productive rock" is of a light greyish yellow colour near the surface, and of a greyish blue a few fathoms down—fine grained and smooth to the touch. The unproductive rock on the contrary is dark blue—very hard and coarse-grained—passing into a sandstone or conglomerate. Similar observations apply to the rocks at East Wheal Rose, Wheal Shepherds and South Cargoll; also to Wheal Rose and Wheal Penrose near Helston.‡ On the whole however it would appear that with lead—as in a less degree with copper—the infiltrations which have brought the minerals into the fissures have been more modified by the character of the original rock than seems to be the case with tin deposits.

*See Notes of Excursions, Report of the Miners Association, 1864.

†See Henwood, Trans. V, and M.A Reports of Excursion, 1864, &c.

‡See T. Clark, Report M.A., 1875, in which he gives good sections of these two districts. I know of no instance where any of the lead veins passing into what I have elsewhere called the Ladock sandstones, have continued to be productive.

Manganese is often found in connexion with very dark-coloured and somewhat hard slates in East Cornwall and West and North Devon. In such cases the slates are commonly found to be bleached where they are in contact with the deposits, as at Lew Trenchard and many othér places.

Iron deposits in the West of England when non-siliceous are commonly associated with killas of very moderate hardness, or with greatly softened and kaolinized granite. When the iron ore is siliceous, the country rock is also hardened by infiltration of silica, and the deposit becomes consequently worthless.

From what has here been said, it is sufficiently obvious that the Cornish miner's dislike of firm highly fissile slate, such as is suitable for roofing, of highly crystalline and sound granite or elvan such as would be valued for building, of clean and solid looking limestone or sandstone—and generally of fresh looking rocks containing pure transparent quartz, little altered felspar or other unchanged minerals; or free from cracks, spots, or stains is well-founded; while the opposite signs are rightly looked upon with favour. Thus we may say in regard to ore-deposits generally that "contact metamorphism" is universal; or at least the exceptions, if any, are extremely few.

7. Ore-shoots occurring in lodes which traverse stratified rocks have usually a pretty definite dip, the direction of which is determined by the relations existing between the bearing and underlie of the lodes, and the strike and dip of the beds, as shewn by M. Leon Moissenet.* In cases where the strata are horizontal, or where the bearing of the lode coincides with the strike of the beds, no such definite dip of the ore-shoots is of course to be expected.

A deep valley, the lower slope of a hill, or at any rate a moderately diversified surface contour, is regarded as more favourable than a table land or the crest of a hill. It would lead us too far to discuss here the reasons for these very obvious facts, they however may be readily inferred from what has been stated above.

* See Moissenet's "Observations on the rich parts of the lodes of Cornwall." Translated by the present author, 1877.

Many other specific characters in the country rocks have been from time to time regarded as unfavourable, such as a harsh texture, and an absence of moisture, especially if porous.

It will be readily seen from what has been stated above that all these characters have a sound scientific basis, while others not so generally recognized will be noted hereafter.

SEC. 7.—*Subterranean Circulation.*

It is a matter of common observation that, subject to small changes such as are due to variations of rainfall, evaporation, or drainage, the water standing in wells and artificial excavations, or flowing from natural springs, maintains a pretty constant level, which is known as the *natural water level* of that particular spot; or less accurately by some writers, the natural water-plane. In elevated regions of porous rocks and intermittent rainfall, this water level is often far below the surface of the ground, and very important results, economical as well as geological, depend upon this fact, as will be seen hereafter. It may be locally altered by pumping or tunnelling; or equalized over larger areas by opening subterranean communications; but subject to minor or local variations it is practically invariable over large areas and for long periods of time.

For our present purpose we may divide the waters circulating within the earth's crust into what may be called surface waters, which do not descend beneath the (natural or artificial) water-level, and those which, descending below that level, are again brought up by ascending currents. The former—the *phreatic* waters of Daubrée will in general have temperatures differing but little from the mean temperature of the region in which they occur,* the latter which may be called *crenic* or *crenitic* after Sterry Hunt,† are the thermals of Daubrée. As by hypothesis they come from deep-seated regions they will in general have higher temperatures than the phreatic-waters; bearing, too, some direct relation in ordinary cases to the depths from which they have arisen. As the temperatures are higher, so the solid

* Unless of course they happen to pass through or over locally heated rocks in which case they may be mistaken for true thermals.

† Mineral Physiography, p. 132 (from κρήνη Gr. a fountain or spring.)

contents will in general be greater than in the case of the phreatic-waters. The incessant transfer of mineral matter from below, through the constantly flowing action of deep-seated springs is thus accounted for by Hunt. "The cooling of the surface of the earth by radiation, and the heating (of waters already there) from below, would establish a system of aqueous circulation by which the waters penetrating this permeable layer (the upper portion of the earth's crust) would be returned again to the surface as the usual springs charged with various matters there to be deposited."* Hunt applies the *crenitic* hypothesis principally to explain the origin of the crystalline rocks—including even granite. But as he saw quite well it is equally applicable to the origin of ore-deposits, if not more so. But the rationale of the process seems here to need some illustration, which I will endeavour to supply.

In the first place, it is evident that the constant flow from each particular source needs a constant supply. Considering that such outflows have been going on all over the world for ages, we may assume that the supply now comes from the surface. It may be derived directly from rain; except, indeed, in countries where rains are altogether unknown; or indirectly from bodies of water supplied by the rains; or from the sea. There are but two ways in which this water can reach the subterranean sources of the ascending thermals, (1) by flowing through fissures (*actual* divisional planes in the rocks which are in direct communication with those deep-seated sources, from which currents of water are made to ascend by heat—and (2) by percolating through the rock-substance (ordinarily though *potential* divisional planes, but often between the separate crystals and particles of which nearly all rocks are composed). The first we may call *canalicular*, the second *interstitial* circulation. At moderate depths the former will predominate—at greater depths the latter—because open fissures will be far fewer, and those which actually exist much narrower in proportion as greater depth is attained: still, it is likely that *some* fissures and actual openings may exist at all depths. The question then naturally arises "How can surface water make its way down below the natural water-level in any given district?"

* Op. cit., p 131.

The force of gravity is plainly insufficient even in the case of open fissures, since any of these which may exist are already full—and under pressures coresponding with their depths. Still less can gravity account for interstitial circulation, which appears to be altogether independent of pressure.* It would appear that canalicular circulation can only be set up by a local lessening of pressure such as would be produced by an ascending convection current—and the very same hypothesis combined with what we know of capillarity and surface tension will account for the interstitial circulation. Thus then, given a permeable rock—whether the permeability be due to minute capillary fissures, or to the cleavage planes of its constituent minerals, or to the boundaries of its separate particles—given on one side a supply of fluid, and on the other a withdrawal of the fluid, and there must be interstitial circulation.† It is this interstitial water in rocks which is called "quarry water" by Daubrée.

Let us now trace a little in detail the progress of this interstitial circulation on the large scale—and with this object in view, we may disregard secondary fissures, anticlines and synclines, variations of porosity and permeability in the beds, and similar irregularities. These would give rise to local irregularities in the rate of the circulation and in the courses of particular streams of particles, but would not otherwise affect it—so that for the purposes of this enquiry we may regard the "country-rock" as a homogeneous and porous mass. Bearing this in mind, we will try to picture the course of the water particles through the rocks under ordinary conditions.

* The tendency of water to pass through *very* narrow channels in all directions increases as the channels are narrowed—while the tendency of one wet particle of rock to wet another lying next to it is so great as to be practically irresistible. M. M. Jamin and Daubrée have shewn that moisture travels—e.g. through a block of sandstone in spite of an opposing gaseous pressure equal to that of many atmospheres, thus answering Gay Lussac's difficult question "How does water find its way to the volcanic focus without being forced back by a tension of vapour below that is capable of sustaining columns of thousands of feet of lavas?" See Phil. Mag. 1861, and Daubrée's *Geologie Experimentale*.

† Daubrée classes rocks as "permeable" and impermeable but not in a strictly accurate sense, since all rocks are to some extent permeable. The rate of permeability as well as the capacity to hold and retain water varies enormously. Thus, while eurite only holds of "quarry water" 0·07 per cent., the clay of Meudon holds between 24 and 25 per cent.—Daubrée, Les eaux......actuelles, p. 6.

Let a.á. (fig. 11. Plate IX.) be a lode-fissure dipping south, and passing through the killas, and down into the granite. Now, assuming the rocks to be everywhere pervious as we know in fact they are, and assuming that there is no deep-seated spring issuing at á, then the waters percolating through the rock from the surface down to the water level e.é., which in this case is also the sea level, will make their escape at é; so giving rise to a phreatic spring on the sea-shore; while in any wells sunk through the rock, or in the shaft *b* the water will stand permantly at that level, all the rock below remaining saturated with practically stagnant water. If now, by sinking the shaft *d* and pumping, the water be lowered to *c* that will be for the time the artificial water level, water will circulate through the rock above that level, and all below *c* will in this case be stagnant.

The same figure 11 will serve to illustrate the more ancient circulation which has often filled such fissures with ore and veinstone. Suppose by the action of subterranean heat a constantly issuing deep-seated upward current or spring at *a*. In this case there will be a constant circulation through the mass of the rock down as far the deep-seated source, wherever that may be. The condition of the water below e.é. or c.c., is no longer static but dynamic. The waters "seeping" through the mass of the rock will be constantly making their way into the fissure at all depths, and joining the outward current at nearly the temperature of the rock itself at those various depths. The water circulation may be considered as an infinite assemblage of molecules moving in files, and their normal courses will be indicated hereafter.

The mean temperature of the issuing water will of course be less than if it had all travelled to, and come from the greatest depth, so that in the absence of strictly local sources of heat we may fairly assume that thermal springs always come from greater depths than would be indicated by their temperatures. For it will be seen at once that different portions of the very same circulating water will reach the ascending stream after passing through rocks at different depths. Hence taking any particular point in the vein, say *x*, the water which reaches the vein above that point has only percolated through the rocks

situated above; we may speak of it as "infiltration from above," and if it deposits anything in the fissure, it can only be material derived from the superficial strata, such as could be dissolved without any particular elevation of temperature or pressure. In the same way waters coming in at deeper points and having higher temperatures due to their greater depths of origin may be expected to dissolve, and afterwards to deposit in the fissure some additional material, and such deposits may fairly be called "lateral secretions." Similarly the waters reaching the fissure at still greater depths, having traversed greatly heated rocks, and having had greater opportunities of meeting with active reagents will be still better solvents, and may therefore be expected to deposit in the fissure, as they rise up through it, still other and different constituents, affording thus examples of deposit by "ascension." This part of the subject will be more fully dealt with in Sec. 10.

The solvent powers of water, especially when heated and under pressure, are so great and general that it has been called with almost literal exactness, the universal solvent. And the springs however charged rarely deposit the whole of their dissolved contents on the sides of their channels, consequently natural springs afford on analysis a great variety of chemical substances. It is indeed remarkable how many of the substances known to us as components of the air or of the solid earth are found to exist in greater or lesser proportions in natural thermal waters. Thanks to the labours of Forchhammer, Bischoff, Daubrée, and a host of other writers, the fifth axiom of my introduction* may be regarded as fully established.

Daubrée† gives the following list of substances that have been found by analysis in such waters.

Gases. Oxygen, hydrogen, nitrogen, carbonic acid, carburetted hydrogen, sulphuretted hydrogen.

Metalloids. Sulphur, selenium, phosphorus, carbon.

* "All rocks and mineral substances are more or less soluble in pure water, and still more so in water containing carbonic acid, or other active chemical substances in solution; such waters in fact as are found to circulate in subterranean channels and fissures."

† Les eaux souterraines.

Acids. Sulphuric, nitric, silicic, hydrochloric.

Semi-metals. Arsenic, antimony.

Haloids. Chlorine, bromine, iodine, fluorine.

Alkaline-metals. Potassium, sodium, lithium (ammonium), rubidium, cæsium.

Alkaline Earths (metals of). Calcium, magnesium, barium, strontium, aluminium, cerium, beryllium, *yttrium*, *zirconium*, *didymium*.†

Heavy Metals. Iron, cobalt, nickel, chromium, uranium, vanadium, copper, lead, zinc, tin,* titanium, *tantalum*, *molybdenum*, *wolframium*, bismuth.

Noble Metals. Gold, silver, mercury.

The well-known examples of metallic and other minerals formed since the time of the Roman occupation by the thermal waters of Bourbonne les Bains, originally studied and reported on by Daubrée,‡ are particularly instructive.

No fewer than 24 species of minerals were formed by the issuing waters, among which were such well-known Cornish species as iron pyrites, vivianite, anglesite, cerussite, galena, chalcocite, covellite, chalcopyrite, erubescite, fahlerz, and cassiterite, besides phosgenite and a number of zeolites—some deposited by the waters itself and others formed by its action on bronzes and works of art. The late Sir Warington Smyth, formerly one of our Vice-Presidents, referring to this wonderful collection of minerals of modern formation, said in his graphic way, "Here we have—within a few yards of the surface and under a very moderate temperature, the metals and alloys which had been produced by human industry; which had been raised by the miner and altered by the hand of the metallurgist, brought again to the identical compounds which we are accustomed to see side by side in their original repositories,—fathoms and fathoms deep underground.§

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* Tin has only been found in a few instances, the proportion being from ·0000015 to ·00000008 per cent. of the water. In Cornwall however the waters flowing through the valley gravels must have contained tin in solution in comparatively recent times, if indeed they do not still; since deer's antlers have been found permeated with that metal. See Trans. R.G.S.C., Vol. x, and "Cornish Tinstones," p. 33.

† The metals in italics are perhaps doubtful.

‡ *Formation contemporaine de diverses espèces Minerales*, Paris, 1876.

§ Smyth, Presidential Address, Trans. Roy. Geol. Soc. Corn., 1876.

There are few mining regions in which thermal springs are not known—although there is some reason to believe that *cæteris paribus* they are less numerous, and their temperatures are lower, in proportion to the antiquity of the deposits;—and even when they occur in non-mining regions they are rarely devoid of metallic constituents.

It has been well said, that while mineral springs and solfatara action are the remnants of volcanic disturbances, an ancient mining region may be looked upon as exhibiting the roots of such a region laid bare by denudation.*

Thermal springs are not unknown in the West of England, although the denudation has been so great and the mineral deposits are so ancient that their action may now be regarded as almost extinct.

Mr. J. A. Phillips, who had made a special study of the relations of thermal springs to ore-deposits, stated some of his conclusions thereon, in 1871, as follows,—maintaining the same position also in his work on ore-deposits, published in 1884.

1. Metalliferous lodes are more numerous and more productive near igneous rocks than elsewhere.
2. There have been volcanic eruptions at all periods of the earth's history (so far as we can read that history in the stratified rocks).
3. Solfatara action and thermal springs are often the latest active evidences of volcanic disturbance.
4. Crystalline quartz, iron pyrites, and other minerals are now being deposited in veins having many of the characters of ordinary lodes, by solfatara action (as at the Steamboat Springs in Nevada).†

The connexion between thermal springs and metalliferous veins is discussed in considerable detail by Mr. Phillips in subsequent papers to that before quoted—and he also refers to a recently formed quartz deposit containing silver, which had been previously described by my friend Dr. Oxland of Plymouth.‡

*"Mineral veins seem to be the roots of mineral springs" Sollas, discussion on Foster's paper on the great flat lode, Q. J. G. Soc.

†See Phil. Mag., Dec. 1871, Origin of Mineral Veins.

‡See J. A. Phillips, Phil. Mag., Nov., 1878.

I must now proceed to shew how the mineral and thermal springs of the West of England are connected with its ore-deposits, and in doing this I must still largely rely upon the work of Mr. Phillips. In the following table, which is based upon one which Mr. H. Tilly presented to the Miners Association in 1872, with subsequent additions, I have brought together such particulars of the Thermal and Phreatic springs occurring in the mines of Cornwall as I have been able to gather.

Name of Mine.	Nature of Ground.	Situation.	Temp. Fah.	Sp. Gr.	Discharge per minute.	Solid Contents in grains per gal.	Approx. depth below sea	Approx. depth from sur.
United Mines, (Lithia Spring, W. Clifford)	soft killas	230 fath. level, N. side of lode	120°-125°	1·0070	150 (1864)	646·1	1320	1600
United Mines	soft killas	250 fath. level, middle lode	106°	—	—	84·0	1440	1700
Wheal Seton	black killas	160 E, N. caunter	92°	1·0123	30 to 50 (1872)	1005·6	780	1080
Botallack Mine (crowns)	dark magnesian slate	245 fath. level	—	1·0105	—	1003·0	1200	1500
Botallack Mine	granite	205 fath. level	—	1·0006	—	42·19	1250	1500
Balleswidden	granite	50 fath., Pye's lode	—	—	—	13·59	100	350
Phœnix Mine	granite	212 fath. level, main lode	65°	1·0002	considerable	14·91	800	1300
Dolcoath	granite	302 fath. level, main lode	92°	1·0007	considerable	46·97	1650	2000

In the thermal springs, although the solid contents vary very greatly, the lowest amount is 84 grains per gallon, while the average is 685 grains. In the phreatic springs the lowest amount was 13·59 grains, the highest 46·97 grains or not much more than half the lowest of the thermals, while the average was only 29·44 grains.

The following substances were found in greater or less proportion in the thermals, viz.—the gases oxygen, nitrogen, and carbonic acid; sulphuric, nitric, carbonic and silicic acids, chlorine, bromine, and iodine, in combination with the following bases, viz.—ammonia, soda, potassa, lithia, cæsia, rubidia, lime, magnesia, alumina, iron, manganese, copper All the above, except bromine, iodine, cæsia and rubidia, were also found in the phreatic waters; and in the greatly modified phreatic water of Dolcoath arsenic was also found.*

The analyses of thermal waters by Dr. Miller and Mr. Phillips, which are quoted above, shew that the first four of those included in Table 1 are essentially diluted sea water, somewhat modified in passing through the rocks,† the dilution of course being occasioned by access of surface waters.

Fig. 12, Plate IX, taken from Mr. Phillips's paper already quoted,‡ illustrates one of the many modes by which sea water after penetrating to great depths through fissures, can make its way into the workings of a mine as a spring. This may be regarded as an example of "canalicular" circulation. Other springs have been noticed in North Roskear, North Crofty, and many

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* Further particulars of these springs with full analyses will be found as follows.

W. W. Smyth (for W. A. Miller, M.D.) British Assoc. Bath Meeting, 1864.

H. Tilly. Particulars of a thermal spring at Wheal Seton. Report M. A. for 1872, p. 53.

J. A. Phillips. Phil. Mag. July, 1873, and March, 1874.

† The most notable modification seems to be that both at Wheal Seton and Wheal Clifford lithia had been taken up from the granite through which the water must have made its way (and in the case of Wheal Clifford cæsia and rubidia also); and at Wheal Seton and Botallack the water besides being diluted—presumably with fresh water percolating from the surface—has *lost* its magnesia to a great extent, while the rocks passed through are *more* highly magnesian than usual—facts bearing very materially upon the theory of serpentinization. See Phillips, Q.J.G. Soc., 123, p. 319, and T. Sterry Hunt, Origin of Serpentine.

‡ Phil. Mag., July, 1873.

other mines in Cornwall as well as in some of the Devonshire mines, but have not been analysed; the last four in Table 1 seem to be merely surface waters—somewhat raised in temperature and otherwise modified slightly in passing through the veins or through old and abandoned workings—so as to partake in some degree of the characters of true thermal waters. All were taken from points above the (artificially lowered by pumping) drainage level of the country, but below the natural drainage level.

The phenomena of ore-deposits throughout the world are only known to us from the surface downwards to at most 5,500 feet, since our deepest shafts and boreholes have not yet exceeded that depth; in fact we have very few workings at present more than 2,500 to 3,000 feet from the surface. But in our deepest workings streams issue whose temperature (and other indications also to which reference will be made hereafter) lead to the conclusion that they arise from greater depths than 4,000 feet. At that depth it does not seem likely—from the most recent observations that the normal temperature of the rocks—apart, that is from strictly local causes, would be much greter than 100° F., yet in some regions temperatures of 200° or more are known. The high temperature of the Wheal Clifford spring does indeed seem to be due to some local cause of heating which is not very deep seated—the far more gradual increase at Dolcoath would seem to come much nearer to normal conditions. In any case we may safely say that in the West of England we have no present information of subterranean temperature by means of springs which have come from a greater depth than 5,000 feet.

This universal subterranean circulation, whether canalicular or interstitial, cannot fail to produce the most extensive changes in the rocks, and especially in a region of ancient fissures such as we have in the West of England. It is therefore of great importance to the geologist and still more so to the miner.

Briefly stated, its work will be:—

1.—To dissolve what can be dissolved.

2.—To transfer material from one place to another, so facilitating mutual reactions and leading to the formation of new deposits,

By dissolving away rock-substance from below by waters subsequently rising to the surface, it has not only brought up large quantities of mineral matter, and deposited it more within the reach of man; but is must have produced chambers within the earth's crust, some of which have subsequently served as depositing chambers to be filled with mineral substances of value; while others, by collapse have occasioned many of the minor irregularities of the strata, and, subsequently thereby, many of the minor surface sculpturings. Such effects are well-known in regions where the strata contain beds of rock-salt and gypsum, and the same must be the case with beds of limestone and dolomite, though the action will of course be much slower.*

We have seen that to some extent all strata may be regarded as soluble, especially in waters which are heated and already charged with active reagents of various kinds; but, except in such cases as those cited above violent deformation is not likely to result from the solvent action of the circulating waters—since it is so very slow—and when even large masses have been removed there has been usually plenty of time for the cavities so produced to become refilled with material brought from a distance.

The great local abundance of certain veinstones as will be seen hereafter is apparently connected with original differences of composition of the parent rocks situated comparatively near the earth's surface. But the occasional local abundance alone or in combination with metals of such metalloids as arsenic, sulphur, and tellurium has probably more connexion with deeper seated sources. The same may be said of the locally abundant fluor spar of many copper, lead, and zinc mines, and of the still more locally abundant boron and fluorine-bearing silicates, schorl, topaz, &c., so generally associated with deposits of tin and kaolin.

The waters circulating in canals and open fissures seem also in some instances to carry matters which are not dissolved but in a finely divided state of suspension; and the deposition of such

*The altered coral reef at Newham, near Truro, now only containing traces of lime, must once have been mainly carbonate of lime, and was probably as many fathoms thick as it is now inches. See "Recent Analyses," Journ. R.I.C, XXIII.

substances, mainly kaolin, owing to its remarkable insolubility and to its finely divided physical condition, has given rise to the "flucan" and "prian" so characteristic of many metalliferous veins.

SEC. 8.—*Subterranean ore-concentration by heat, pressure, and the crystallizing forces.*

The whole course of modern investigation as to the origin of valuable metalliferous deposits goes to show (1) that the metals sought are very widely distributed through the rocks forming the earth's crust, and (2) that only those deposits are worth working which represent notable concentrations of the said metals. We have now to consider the nature and mode of operation of the forces, or forms of force, concerned in this natural subterranean concentration.

Sir Geo. Groves' study of the correlation of the physical forces has been one of the most profitable labours of modern times. So much, and so intimately are they related that it is impossible properly to appreciate the effects of one without being continually led to consider others. "Light runs into heat; heat into electricity, electricity into magnetism, magnetism into mechanical force, mechanical force into light and heat; the proteus changes, but he is ever the same."* I will, however, endeavour to discuss their actions separately in connexion with rock-change and the formation of ore-deposits, as far as may be possible or convenient.

1.—*Action of heat and pressure.* The simple action of heat on rocks is observable when a lava-stream flows over their surface. Clays are locally converted into porcellanite or ferruginous jasper,—as, for instance, at Portrush, where certain beds of lias-clay have been converted into a hard brittle splintery rock, when in contact with a large body of trap-rock.† Equally marked changes have frequently been noticed in connexion with beds of sandstone.

But heat alone, without accompanying and considerable pressure, can only act on rocks at the earth's surface, and with little intensity even then, except locally. But the rocks and ore-

* Tyndall, quoted by Chas. Fox, Address Miners Assoc., 1862.

† Jukes and Geikie, Manual of Geology, 1872, p. 140.

deposits with which we are particularly concerned were penetrated by eruptive rocks while still far below the surface, and consequently subject to heat and pressure corresponding to many thousands of feet of overlying rock. It is not surprising, therefore, that effects have been produced entirely different. For example, when chalk is heated by a lava-stream in such a way that the carbonic acid can escape, it is merely converted into quicklime. But if it be similarly heated in the depths of the earth under great pressure, it is converted into granular limestone or crystalline marble.‡

In the changes just referred to moisture does not seem to have played any important part. But, as we have already seen in the preceding section, the solvent powers of the fluids circulating through the rocks are greatly increased and extended by increase of heat and pressure, so that substances ordinarily regarded as insoluble have been brought into solution, transferred to other points, and finally re-deposited in suitable *gites*. Thus silicates have been decomposed and dissolved—new silicates have been formed—free silica has been deposited—and the separated bases have been converted into sulphides, sulphates, and other comparatively stable compounds; while the haloid salts of alkalies, derived in all probability from pre-existing complex silicates, have gradually accumulated in the waters at the earth's surface.

In the West of England, it is doubtful whether effects of heat and pressure can be anywhere seen without the superadded effects of other changing agencies yet to be described. It seems certain, for instance, that such flinty slates and sandstones as those of Haytor, described in Sec. 2, have not only been consolidated by pressure and baked by heat, but also infiltrated with silica; while the crystallizing forces have developed within them new minerals, such as magnetite, garnet, and hornblende; the materials of which were in all probability already present in the rock.

‡ The result of such heating may be seen in many places in the North of Ireland, where the chalk, being penetrated by dykes of basalt, is altered into a hard grey semi-crystalline limestone, or into a coarsely crystalline white marble. The well-known experiment of heating chalk in a closed gunbarrel has a similar result.

2.—*Action of molecular affinity and of the crystallizing forces.* The tendency, everywhere observable in mineral substances, of like particles to approach each other whenever freedom of motion is permitted, seems to depend upon an affinity of the molecules which is quite distinct from what is known as chemical affinity—this latter being strongest between unlike molecules.

Molecular affinity seems to be the originating agent in the production of concretionary structure in colloids, and of sporadic crystallization, the devitrification of glassy rocks, and crystallization generally in crystalloids. The subsequent development of crystalline structure in colloid aggregations is a related but distinct phenomenon which is also frequent.

To enable this molecular affinity to operate, freedom of motion of the particles is, of course, necessary. This exists originally in both eruptive and sedimentary rocks to a very considerable extent. In eruptive rocks fusion, or the pseudo-fusion due to the presence of moisture at a very high temperature, facilitates the formation of such concretionary aggregates, mostly more or less crystalline, as occur in the granites of the West of England,* and also of the sporadic crystallization generally, which results in what is called "porphyritic" structure. This may be on a large or small scale—"macro"- or "micro"-porphyritic. The separate crystals or crystal-groups are in some cases developed in a glass in a cryptocrystalline base, as in the case of most of the "elvans;" or else in a well crystallized granitic base, as may be seen in much of the granite in all parts of the two western counties.

In stratified rocks such as clays, mudstones, sandstones and limestones, concretions of ferruginous, phosphatic, or siliceous (cherty) matter of a colloid character; cubes of pyrites; crystals and crystal-groups of gypsum and other crystalline minerals are often thus formed before complete consolidation. Such are good examples of the action of "molecular affinity" in bringing together like particles of matter already existing in a diffused condition throughout the mass. I proceed to refer to a few examples in detail.

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*Phillips, *Quart. Jour. Geol. Soc.*, xxxvi, p. 1 and xxxvii, p. 216.

At Lyme Regis the lias-clay, as is well known, contains numerous calcareous concretions.* Concretionary beds of earthy carbonate of iron (clay iron ore) have been met with associated with the anthracite beds of North Devon, at Bideford, and Chittlehampton, although not, I believe, to a sufficient extent to be of economic importance;† such beds in the carboniferous rocks of Staffordshire and Wales are, however, of the highest importance.

The same may be said of the concretionary and nodular iron pyrites which has been met with in the "killas" in many parts of the West of England. These are of economic importance in the chalk of Kent and Sussex, and in the London clay at Sheppey and elsewhere. Concretionary patches of peroxide of iron occur on a small scale in some of the sandstones of the Ladock district, as also in some of the elvans. These also are too small to be of economic value.‡

A singular specimen, "resembling a chalk flint," which was found in the lode at Balleswidden, was described in 1865, by Mr. S. Higgs. It occurred in a vugh at the 130 fathom level, and was surrounded by decomposed felspar and quartz granules. Mr. Higgs thought it had fallen in from the surface, but its mode of occurrence and surroundings rather suggest that it was a concretion of siliceous matter.§

Mr. Henwood mentions some "globular concretions" in the lodes at Wheal Duffield, Relistian, Trevaskus, and Wheal Herland, containing kernels of slate, granite, elvan, and copper-pyrites, and says similar concretions exist in the country rocks.‖ Dr. Le Neve Foster,—who saw similar masses in the lode at

* In these a lamellar structure is often developed, parallel to the bedding and lamination of the containing rock. This is doubtless a subsequent development, arising either from pressure, or perhaps from transverse electric currents as will be shewn hereafter.

† Delabeche, Report on Cornwall, &c., p. 125.

‡ The concretionary aggregations of peroxide of iron in the sands of Sussex were formerly the source of all the iron used in the South of England—and this for a long series of years.

§ Trans. R.G.S.C., IX, 1865, p. 1.

Trans. R.G.S.C., V, p. 39.

New Rosewarne, on a continuation of the Relistian lode—considers them—though with some hesitation—to be true pebbles, fallen in from above.*

Many concretions occurred formerly in the lode at Wheal Trelawney. One, consisting of a kernel of galena succeeded by four layers of quartz, the fourth containing fragments of the third, and coated over all with galena, is described and figured by Mr Henwood.† The concretions remind one of the well-known "ring-erz" of the Hartz.

The concretionary form of tin-oxide, known as wood-tin, has often a concentric, and frequently also a radiate structure, as at the Garth Mine near Penzance, Wheal Metal in Breage, Penhalls in St. Agnes, Prideaux Wood near Par, &c.‡ The former is probably an original concretionary colloid structure, the latter more probably a superinduced crystallization. Many of the distinctly crystalline tin-stones have also a somewhat radiate structure,§ as in the case of the toad's eye tin from Penhalls, this therefore is rather to be described as an example of the sporadic crystallization to be adverted to presently.

In all cases of concretions in sedimentary rocks it seems likely that the determination of the position of any particular concretionary aggregation depends upon the presence of some fragment of organic substance which has served as a nucleus. We can hardly suppose a similar determining cause in the case of concretions in eruptive rocks or in veinstones, although Mr. Moore long ago proved the existence of numerous organisms in the flucans of the lead veins in the Mendips.||

Spheroidal structure is really a form of jointing, but it often occurs with concretionary structure, and is often confounded with it. This structure is most common in eruptive rocks, although it also occurs in sedimentary rocks.

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* Report M.A., 1866.

† Trans. R.G.S.C., VIII, p. 703.

‡ See Plates VIII, IX, X, XII, Cornish Tinstones and Tin Capels.

§ Ibid, Plate V, figs. 1 and 3.

|| C. Moore "On the organic contents of mineral veins."—*Brit. Assoc. Rep.*, 1869. A list of nodular concretionary bodies surrounding organic bodies is given by Mr. M. H. Johnson. *Jour. Quekett Microscop. Soc.*, May, 1875.

Usually in the granites and elvans of Cornwall the material of the spheroids differs but little from the surrounding rock-substance. In crystalline rocks the crystals may be a little larger,—or occasionally a little smaller—the rock may be, and usually is more compact in the spheroid, and there may be, and often is, a greater proportion of some one mineral component present. These two latter causes are probably the reason of the curved "joint" which separates the spheroid from the matrix.

The structure is so common in the eruptive rocks of the West of England that scarcely any quarry or road-cutting can be examined which does not afford examples more or less perfect. The best examples are afforded by the mica-traps near Falmouth. That which is seen near the Penryn saw mills, where the dyke is only 3 or 4 ft. wide, is almost entirely composed of spheroids—many of which shew, by weathering, three or four concentric laminæ, although in the fresh state the joints only appear when the rock is struck with a hammer.* Some spheroids in the dyke of this rock which appears in the cliffs below Mawnan Church, are not less than 8 ft. in diameter.

Spheroidal structure is often visible in the sandstones and grits of the neighbourhood of Ladock—this too is accompanied by a concretionary accumulation of phosphate of lime, but only to a very small extent.

The structures known as spherulitic and perlitic are related to the spheroidal structure, being curved joint structures—but they do not appear to be in any way associated with concretions. On the whole we may say that concretions are of little economic importance in unstratified mineral deposits, and especially in such as are most usually found in the West of England—though they are often of vital importance in bedded deposits—as for instance in the clay ironstones of the Coal Measures, the phosphatic deposits of the chalk, and the galena of the Mechernich sandstones.

Sporadic crystallization and crystal aggregates. In an incipient state, sporadic crystallization shews itself in the spotted schists which are so common on the borders of the various granitic

* See R. N. Worth, Rep. M.A., 1883. See also Geol. Age of Cornwall and W. Devon, Journ. R.I.C., 1884, p. 39.

masses of the West of England. The study of these belongs to contact metamorphism generally, and has no particular relation to the phenomena of ore-deposits. The same may be said of the crystalline concretionary patches in the granite already referred to, which consist of "an abnormal arrangement of the crystalline minerals of the granite itself, found by microscopic examination to be practically of the same composition, but usually containing more mica."*

The most noticeable sporadic crystallizations on a large scale (macro-porphyritic) to be seen in the West of England are, no doubt, the "horse-tooth" crystals of orthoclase, and the cross-macles of the same mineral in the granite of Tol-Pedn-Penwith, and elsewhere. The separately developed crystals of orthoclase in the elvans are often very striking. But next to orthoclase, black tourmaline or schorl is the most striking mineral thus developed, and there is good reason, too, to regard it as a secondary mineral in all cases, *i.e.* it has been formed after the original consolidation of the rock.

Schorl occurs almost invariably in acicular crystals, and often with radiate arrangement; the occurrence of independent prisms more than $\frac{1}{16}$ of an inch in thickness being rare, although Bovey Tracey, Stenna Gwyn, St. Agnes, and Tremearne may be mentioned as localities for such larger prisms.

As was pointed out long ago by Delabeche, schorl seems to be limited to the neighbourhood of the granite junctions, whether it occurs in the granite or in the killas. It is abundant under the following conditions.

1. As schorl-rock, which appears to be merely an altered granite, and is, I think, always near killas—as at Roche Rock, St. Mewan Beacon, &c. It is sometimes notably stanniferous, as at Rock Hill near St. Austell. Other modifications of granite containing schorl are the varieties known as Luxullyanite and Trowlesworthite.
2. As tourmaline schist, which is merely an altered killas, as at the Gwennap Mines, Wheal Vor, the south side of Carclaze pit, &c.

* Phillips Q.J.G.S., XXXXI, p. 1, and XXXVIII, p. 216.

3. As a constituent of many elvans, as at Seveock and Terras.
4. As distinct veins in kaolinized granite (Petuntzyte and Carclazyte) often associated with quartz, and sometimes with tin. It is in such veins that the separate and well-defined prisms already referred to usually occur.
5. As globular radiate crystalline masses, in similar situations. Some of these are so regular in form as to be mistaken for pebbles.*
6. As an important constituent of tin-capels, both in granite and killas—as at Wheal Uny, Dolcoath, and other mines.†
7. As fine green, brown, gray, or silver-white hair-like crystals (achroite) as a secondary deposit in schorl-rock‡ or imbedded in quartz crystals.§

The crystals of tin-stone lining minute fissures, joints, and cavities; which are of such importance in the numerous stockworks in Cornwall, appear to be examples of local concentration of previously existing material widely diffused in minute particles throughout the rock-mass, produced by the operation of the crystallizing forces. It has already been stated that the tin-oxide present in the killas at Mulberry is little over one quarter of one per cent. Were this distributed through the rock-mass in particles as minute as those of the workable tin capels of the Camborne district, it would be quite impossible to work it at a profit. It is only because the crystals are comparatively large, so allowing of much coarser stamping and much cheaper dressing, that such poor deposits can be worked at all.

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* Dr. C. Le Neve Foster describes such masses as occurring, from one to five inches diameter, in the decomposed granite of Ding Dong near Penzance. Trans. R.G.S.C., IX, p. 9. See also Delabeche, Report, &c., p. 158.

† See Cornish Tin-stones and Tin Capels. Plate IV and p. 11.

‡ See Min. Mag., Vol. I, 1876, on the Achroite of Rock Hill, p. 55.

§ The secondary development of schorl has been illustrated by Prof. Bonney in the cases of Luxullianite and Trowlesworthite, (Min. Mag. I, p. 15, and Trans. R.G.S.C., X, 185), and its origin and general associations with Cassiterite, as well as with Topaz and other fluorine bearing minerals, has been fully dealt with in connexion with the hypothesis of Von Buch, Daubrée, and others, by the writer (Tin Stones and Tin Capels, p. 136 *et seq.*).

In many cases, where original components of the rocks are in question, the freedom of motion existing in the rock-masses before complete consolidation would be sufficient to allow of the formation of crystal aggregates of considerable size. In other cases, so evenly balanced are the aggregating and retaining forces that the presence or absence of actual cavities is sufficient to determine whether there shall be such aggregations or not. But we know that mineral growth is possible, and indeed is often effected in rock-masses after complete solidification. The necessary freedom of motion, and the spaces for the new aggregations are provided slowly but simultaneously,—the solvent powers of the circulating solutions being aided by heat and pressure, and the aggregating tendencies by electricity, surface-tension, and, sometimes, by direct chemical reactions. So continuously, though slowly, do these changes go on, that, in some instances, well-formed crystals of large size have been formed around suitable nuclei in already solidified rock-masses, as shewn by Judd, and others.* Even the pressures resulting from rock-movements may be thus effective, by controlling the chemical affinities and crystallizing forces.

* Q.J.G.S., 1889, p. 175. Mr. Judd found that detrital fragments of quartz, felspar, hornblende, and mica had become enlarged under these conditions, and that crystals of many kinds had also been enlarged, those of felspar even after partial kaolinization.

[*To be continued.*]

A Year's Weather.

In looking over the weather chart for January, 1891, the coldness of the days and nights and occasional heavy rains are its prominent features. During the month the barometer stood very high, its mean height being 30·15-inches; its highest registration being 30·70-inches, on the 14th; its lowest, 29·57-inches, on the 24th.

With the barometer standing close on thirty inches (29·87) on the 8th, we had over one inch of rain (1·01). Unlike some places, we had not to complain of absence of sunshine during the month, for the sun shewed itself on twenty-four days. As our average January rainfall is 4·85-inches, we must look upon the rainfall of the month, 3·40-inches, as very favourable; and as 2·43-inches of this rain fell on the 8th, 23rd, 28th, 30th, and 31st, the month was somewhat dry.

The Truro rainfall in January 1890, was 5·62-inches, which fell on twenty-eight days—a very wet month.

It is singular that the average rainfall throughout Britain for the same month was only 2·07-inches, which fell on nineteen days. The 8th was a phenomenal day. We had nearly one inch of rain from 5 p.m. to 8 p.m.—three hours—then a thick mist, which cleared, permitting showers of meteorites to be seen falling from the N. and N.N.W. direction; during the same night the thermometer registered seventeen degrees of frost.

Our coldest night was on the 11th, when twenty-one degrees of frost were registered out of doors, our next coldest was on the 18th, with twenty degrees of frost.

Our monthly mean of greatest cold in night taken from thermometers which are in a louvred weather-house was 33·6 degrees. We have had, during the last fifty years, only two averages so low—January, 1855, 32·9 degrees, with only ·65-inches of rain on eight days; and 1881 (the year of the great storm), 28·0 degrees; probably the coldest January Cornwall has ever known. We had snow on the 17th.

February 16th, 1891.

In my last letter I drew attention to the great height of the barometer in January, the occasional heavy showers, and the coldness of the nights. The old distich says: "February fill dyke, either black or white," but February this year was one of the most delightful probably on record. Except for the general absence of flowers, kept back by an unusually cold season of three months' duration, one could not, during the greater part of February, have had any idea from casual observation that it was winter. The blueness of the sky day after day, relieved by cirrus clouds—frozen mistiness, ice crystals—the genial glow of the sun, unchecked from earliest morn until it dipped—as I saw it several times during the month—in a setting of resplendent purples, greens, and yellows right over St. Ives Bay, beyond Cape Cornwall, its glorious disappearance bringing out the moon which reflected from a sky cf continued clearness its silvery rays. Towards midnight, chiefly from the region of the Great Bear, brilliant meteors shot out, falling into the illuminated arena beneath. The mean height of the barometer, 30·42, was higher even than January—30·15-inches. Our mean of heat in shade during the month was 54·3 degrees, the mean of cold in night 34·9 degrees; we had fourteen nights on which it registered frost; our coldest night was on the 10th, with 8 degrees of frost. We had hoar frost, a heavy dew, and mist on three occasions; this latter represents, of course, the fog of densely populated towns, fog being mist (water) particles, enwrapped in smoke (carbon).

Beyond doubt February, 1891, will be best remembered for its dryness. Rain fell here only five times during the whole month, the total fall being ·22—under one quarter of an inch. February last year it rained 1·84-inch on 12 days, and we had hail. For easy reference I append the mean of 40 years' rainfall, and the rainfalls of last year and this, which I hope to continue from month to month:—

	40 years' mean.	1890.	1891.
January......	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
Totals...	8·23-ins.	7·46-ins.	3·62-ins.

I cannot find any record these last fifty years of so dry a February as 1891, the nearest being those of 1887 (·77-inch) and 1888 (·85-inch). These were unusually dry, but the driest of them was three

times as wet as that of the present year. During the same long period I find the following months only were as dry or drier than February this year:—April, 1854 and 1870; May, 1876; August, 1880; and June, 1887. To peep back into Cornish weather phenomena through Mr. Francis Gregor's observations, made at Trewarthenick over one hundred years ago, which this Institution possesses, is very interesting. The varying aspects are made in diagrams. February, 1771 (120 years ago), snow fell on the morning of the 10th, and remained on the ground till the evening of the 11th, and finally disappeared on the afternoon of the 13th. On eight days it was frosty. It rained on eleven days, but only heavily during the night of the 24th. In February, 1791 (100 years ago), were fifteen fine, six cloudy, and seven rainy days; so we may safely infer that our ancestors of that time enjoyed a bright February.

March 3rd, 1891.

The exceedingly dry February has been followed by one of the most remarkable March months on record here. Instead of drawing comparisons of dryness or wetness, one is lost for want of a parallel to compare, not rainfalls but snowfalls. It would be hard to describe briefly the unique appearance West Cornwall presented in the middle of the month. It will be long remembered in this part for its damage to trees, its fatality to sheep—one gentleman alone lost nearly 200 of these valuable animals; and its stagnation of trade, yet even now, it is hard to realize that snow fell so heavily for three days in March, and was so drifted by the wind that for several days this city lapsed into more than primitive isolation, for it ceased to do business by road or rail; did not read a newspaper, nor heard the postsman's knock.

Cornish people remember nothing like it, except the proverbial oldest inhabitant, whose memory recalled to me a violent snowstorm some fifty years ago, when the snow buried the hedges, hid the gates, caused the waggoners to leave their waggons ladened with timber for the mines for days by the roadside, and prevented all the usual occupations of every-day life being carried on. On referring to the earlier journals of the Royal Institution of Cornwall, I find this very violent snowstorm recorded as occurring from the evening of the 14th February to the morning of the 16th, in the year 1838

But just as the rainfall in February varied in different parts of Britain, so did the downfall of snow. In the North of England, they did not venture to name the snowstorm they had, a blizzard. Our heaviest fall was on Tuesday, March 10th, and on the same day of the month, but twenty-eight years ago—on the wedding-day of the Prince and Princess of Wales—a snowstorm exactly like that we had swept all over the North of England and Scotland.

The snow fell chiefly on the 9th, 10th, and 12th; the heaviest and longest fall being from noon on the 9th until nine o'clock on the morning of the 10th. The snow was so drifted that it was hard to measure, but a series of averages gave on the 9th, 12-inches; 10th, 1·5-inches; 12th, 8-inches; or a total of 21·5-inches. Owing to the cold wind the snow remained on the ground in many places for the rest of the month.

Taking all downfalls (snow, hail, and rain), as rainfalls, we had in March 3.90-inches, which is above our mean average for this month as shewn below :—

	40 years' mean.	1890.	1891.
January ...	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
Total ...	11·14-ins.	9.33-ins.	7·52-ins.

The rainfall for March, 1889, was 4·74, March, 1888. 4·70, and March, 1851, 7·11-inches.

It is asserted that if the barometer stands high in the winter it will, in all probability, be low in the summer—*i.e*, a cold winter with a high barometer, means a low barometer in the summer, with accompanying dulness and coolness. I append the mean barometrical heights for the last few months at Truro, as such observations may be useful to many :—

1890, October, 30·149-ins.	1891, January, 30·197-ins.
1890, November, 29·927-ins.	1891, February, 30·419-ins.
1890, December, 29·960-ins.	1891, March, 29·855-ins.

The mean of these means is 30·084-inches.

Our mean of greatest cold for the month was 35 degrees.

In March, 1791, one hundred years ago, there were 23 fair, 5 cloudy, and 3 rainy days.

April 8th, 1891.

It is many long years since Cornwall so much needed "the April showers to bring forth the May flowers." The chief rainfalls were, with the exception of a little in the middle of the month, at the very entrance and exit of April. The few true April showers —mixed rain and sunshine—which fell, were chilled by cold winds, which prevented much of the good the warm spring rain does. They came easterly with surprising continuance.

It was interesting at times to notice how floral nature struggled to get out of the bondage. Here one saw a little beech under the shelter of some bigger tree, shoot forth its whole array of yellow-green leaves, whilst a sister tree on the edge of the self-same coppice awaited sullenly the advent of the warmer weather. The primroses felt this struggle keenly, yet under the meanest protection they overran the walls and meadows. This year this pretty plant will be at its best in May. In early April I botanised in a sheltered nook, where the lesser celandine, primrose, violet, ground-ivy, and others were in flower, and the bees were almost as plentiful as blossoms; and the worker bees were savage with the rifled flowers they visited. April must have been bad for bees, *Apis* and *Bombus*.

The barometer stood nearly 30-inches (29·926), but the thermometers, on some days, indicated great ranges of heat and cold. The average greatest heat was 56·4, the average greatest cold 39·4 degrees, an average difference between hottest and coldest aspects of 17 degrees. It was a dry April, its rainfall of 2·48-inches on thirteen days compares favourably with the 4-inches of rain last April, and the forty years' average of 2·61-inches. We had a little hail on the 3rd, frost one night.

The apple, cherry, and plum trees came into flower in sheltered places, the hawthorn, sycamore, and horse-chestnut came into leaf. On the 14th the swallow was seen in Ladock valley. The cuckoo was heard at Trenowth, Grampound road, on the 21st, at Cuckoo Bottom, Besore, Truro, on the 24th (a day late). Evidence here too, of the westerly distribution of "the harbinger of spring."

The average rainfalls to date are as below:—

	40 years' mean.	1890.	1891.
January	4·85-ins.	5·62-ins.	3·40-ins.
February	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
Total	13·75-ins.	13·34-ins.	10·00-ins.

From the table we learn that the Truro rainfall for the first four months of this year is less by 3¾-inches than the average mean rainfall for forty years, *i.e.*, the land has received this year, 84,750 gallons of rain water less per acre than usual.

May 9th, 1891.

I have to record a cold and somewhat dry May month, the rainfall being nearly a quarter of an inch below a forty years' average. As will be seen from the table appended, we are still in the enjoyment of much drier weather than last year. The registration of the rainfall of this May and last shews that we have had less than half the rain this May month than last. The rainfall for the first five months in 1890 and 1891 show a difference of nearly six inches and a quarter.

	40 years' mean.	1890.	1891.
January	4·52-ins.	5·62-ins.	3·40-ins.
February	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
Total	16·20-ins.	18·40-ins.	12·26-ins.

The rainfall at Truro for May was 2·26-inches, which fell on eighteen days.

Perhaps no month in recent years has been so disappointing as May, 1891; and yet, judged from a weather chart, it seems hard to say why. The mean here of the maximum heat for May, is 61·10, we had this year 61·60 degrees. The mean of the minimum is 44·94, we had 42·50 degrees, or 2½ degrees colder than usual. Last year our hottest May day registered 77 degrees; our hottest this year 73 degrees, or 4 degrees colder. Our coldest night in May, 1890, was 39; this May, 30 degrees, or 9 degrees colder.

Even natural observations gave no direct clue to the cause of this disappointment. Oak should be in leaf on May 13th, was in leaf on the 5th. The ash came into leaf on the 10th. The horse chestnut should be in flower about May 6th, was, with us, on May 8th; the lilac on the 5th, was in flower on the 6th; the laburnum on the 14th, was in flower on the 9th. The swift and the corncrake were a few days late.

Perhaps the best explanation of the discomfiture so much complained of in May, was in the sudden change of the weather. We were unusually buoyed up by the fine hot week preceding Whitsuntide. The hottest day of the month was then, when the heat in the shade was 73 degrees, and the night temperature was 50; a week afterwards (Whitsuntide) the highest day temperature was 50 degrees in shade, the minimum temperature of the previous week, and the night thermometers registered 2 degrees of frost, a fall of 20 degrees of heat, accompanied by northerly winds, heavy rains, and a little hail. In many parts there were heavy falls of snow; Rugby 7-inches, in London blinding showers of sleet and snow, accompanied by thunder.

On the 1st of May, 1791 (100 years ago) grass was so luxuriant that many people had their cattle out a fortnight earlier than usual. A week afterwards, on the 8th, wheat changed colour and appeared yellow, and potatoes above ground were nipped by the frost and their branches turned black; grass was making no progress. About the date of our Whitsuntide this year there were cold, raw, gusty winds, and eventually a piercing gale. In that year (1791) the hawthorn blossomed, and the corncrake was heard on the 25th; this year (1891) we saw and heard the same on the 18th.

After all, in the matter of weather, we are living under very much the same conditions as in the "good old times."

June 8th, 1891.

"Leafy June!" Perhaps the ordinary mind cannot recall a June so leafy as the last one. The cold weather, prolonged into the lap of May, relaxed its severity when plant life could scarcely tolerate the bondage longer. And then we saw nature robed in primary and secondary growths, untouched by insect or fungoid parasites. Throughout Cornwall the heavy foliage, casting a deep shade beneath the trees, was marvellously developed and wonderfully free from ravage. As the trees clothed some of the valleys, where one got an extended sight of them, they presented, perhaps a more sombre picture than usual with June leaves, but this sombreness disappeared on nearer approach, and the newer growth was seen to overtop, to cover up, and to merge into the older tree growth. This new growth was a revelation to the observer; a holly bush over which he may run his hand at will and touch or grasp nothing but soft non-pricking leaves, is what June does not always bring to us.

Cornish hedgerows! No words can fully describe them. The rank verdure on them defies description. A strip of bordering ground carpeted with buttercups, or silver-spread with daisies—the common and the dog kinds—helps one better to see them. It gives the distance. But who can describe the blending of flower colours, or the struggle for existence? The picture was made by most favourable June weather, which intensified a struggle keen at all times. How pretty the flowers were! The blue-buttoned sheep's-bit; the deep yellow bird's-foot; red campions, white umbels, o'erhung with scented honeysuckle, wild rose, and elder.

It was not an exceptionally dry June. Our average rainfall at Truro is 2·39-inches, and this month we had 2·86-inches, which was over the average of the last ten years, and below the average of the preceding thirty years There was this peculiarity about the month, that it followed a very cold May month; it opened with warm rain, and then we had nearly three weeks of dry weather, which got hotter and hotter until it reached with us, 82 degrees in the shade and 112 in the sun. Plant life received an impetus, rarely equalled, in this brief period. Although we had rain—in some cases scarcely measurable—on thirteen days, the bulk of the rain fell on four days, on the first, 1·0; on the third, ·54; sixth, ·59; and 30th, ·38-inch, or 2·51-inches out of the total month's rainfall of 2·86-inches. The driest June for forty years here is June, 1887, 0·5-inch; the wettest June, 1861, when 6·71-inches of rain fell.

We can now get our average half-yearly rainfall, and can see at a glance how much drier this year has kept than last. The table which shows the comparisons clearly, gives about 7½-inches less for the first six months of 1891 than the same period in 1890.

	40 years' mean.	1890.	1891.
January	4·85-ins.	5·62-ins.	3·40-ins.
February	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
June	2·39-ins.	4·17-ins.	2·86-ins.
Total	18·59-ins.	22·57-ins.	15·12-ins.

Finding that the observations of the weather, 100 years ago, excite much interest, I may say of June, 1791, that on the 1st the grass was at a standstill for want of rain; a few days afterwards

green peas were in the market, and new potatoes were 1½d. a pound. Clover hay was cut on the 7th, and on the 11th it came in seriously cold, hail storms, ice upon the pools, the grass began to decay in the pastures and meadows, apples dropped off the trees; the strawberries were very poor, as the leaves and stems were shrivelled up by the storms. They had 17 days of wet, and one day, the 3rd, when it was 120 degrees in the sun.

I have dwelt at some length on the natural aspects of June, as the reader would do well to note and make for himself observations which may not be presented so favourably again for years.

July 8th, 1891.

Although rain fell here on seventeen days, the amounts were so small that the monthly total of 1·62-inches shows the same general tendency to dryness which has characterised every month except March this year. The mean of the rainfall of July during the last ten years is 3·06-inches, of the previous forty years 2·60 inches. The rainfall this month is one inch below the most favourable of these averages. During these ten years we have had the second driest July for the last fifty years—1885, 0·40-inch; 1869, 0·35-inch; and the second wettest July for the same period, 1888, 6·45-inch; 1867, 6·71-inches of rain. In 1888 it rained 1·30-inches on the 15th, and in 1880 1·46-inches on the 16th; these are the heaviest day's rainfall in July on our registers.

Though the month's rainfall was so little the total number of days on which rain fell was quite up to the average of a wet July, and even on some of the rainless days nimbus (rain) clouds gathered and absorbed in their watery curtain the heat the earth would gladly have had, hence the month was not so sunshiny and hot as one would have expected, the daily and nightly temperatures being a little below the average. The prevailing winds, too, were northerly. The highest reading of the thermometer was on the 15th, 79 degrees; the lowest, 40 degrees, on the night of the 13th; this difference of 39 degrees strikingly shows how the temperature ranged during the month. The mean temperature of air for the month, got by taking the means of the maximum, minimum, and dry-bulb thermometers, was 63·3 degrees. The range of the barometer was a little over half-an-inch (·56), the highest reading being on the

14th, 30-29; the lowest reading on the 1st, 29·73-inches. We had thunder on the 20th, and thunder and lightning on the 26th, which ushered in a week marked by driving showers of sleet-like rain.

If the average rainfalls are tabulated, we can see how much drier the year keeps than 1890:—

	40 years' mean.	1890.	1891.
January	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
June	2.39-ins.	4·17-ins.	2·86-ins.
July	2·60-ins.	3·67-ins.	1·62-ins.
Total ...	21·19-ins.	26·24-ins.	16·74-ins.

A total of 9½-inches less of rain for the seven months of this year than in the same period of last year, or nearly 4½-inches less than the 40 years' average of the same months.

In July, 1791 (100 years ago), the people complained of wind and rain. There was a general want of grass at the beginning of the month, but this improved, and when about the 28th the hay harvest finished, the crops, though not heavy, were superior in quality to the long coarse grass of the previous year, and well got. Gooseberries were ripe on the 13th, and on the 16th the blackberries were in bloom, and the wheat, too. The monthly rainfall was 2·50-inches, and on the 25th thunder was heard, and in some places hail fell.

August 11th, 1891.

It is extremely gratifying to receive the expressions of great pleasure the perusal of this course of weather letters has given rise to, and to learn, that not only is their appearance looked forward to with interest, but many trust they will be continued beyond the year.

August, 1891, will be long remembered as one of the wettest Augusts on record. There have been many attempts during those of the past forty years to be wet, but none so successful as the last. We read of meadows being submerged, of ripened wheat and barley being uncut, of good crops of cereals in which the grains had begun at once their new growth. It was a month of feeble sunshine, struggling between filmy mists or extinguished by down-pouring

rain. Recollections of weather changes touch the general mind but lightly, unless, like this month, they are struck deeply by some phenomenal display. What was seemingly going to be so dry a year, broke its bondage when one of the most bountiful harvests for twenty years touched with golden gladness hill and dale. The abnormally swollen little streams and rivers about us, told a tale of soddened land, and the heart felt grieved on reflecting at the sad havoc wrought by the untoward rain.

August is not the driest of months, nor is it the least free from heavy downfalls of rain, an average of many years shews it to be little drier than February, and wetter than March, April, May, June, and July, The average August rainfall here is about 3-inches, this month it rained at Truro 6·48-inches, over twice as much as the average, and my friend, Mr. F. H. Davey, of Ponsanooth, who has taken charge of a rain-guage for us for nearly two years, recorded 7·31-inches. During the month it rained on 25 days, on one day nearly 1½-inches, on another over ¾ of an inch, on three ½ an inch, and on six over ¼ of an inch. This heaviest day's rainfall in August was on the day set apart for the excursion of the Royal Institution of Cornwall. The representatives of the press of the two counties, who were in the waggonette in which we rode, will bear me out in saying that a merrier party never rode together than ourselves; while that 1·48-inches of August rain poured on us. We rode through miles of it, the roads had all the appearance of shallow muddy rivers, the wheels of the vehicle cleaved the water just as they do in running across some shallow ford. We were merry about the rain, but a word of sympathy ever ran in the conversation for the suffering farmer. It is beyond my province here to calculate the miles we went, but every acre we saw of ripening grain had not one ounce less than 150 tons of water poured upon it that day.

There have been some inquiries as to whether we have had any very heavy daily rainfalls in August. We have! It is a month noted for what the meteorologist calls "remarkable rains." The one quoted is an example. I add a few other daily August rainfalls for reference:—1891, 20th, 1·48-inches; 1890, 9th, ·92-inch; 1885, 5th, 1·06-inches; 1875, 11th, 1·36-inches; 1874, 31st, 1·06-inches; 1866, 28th, 1·05-inches. The following are a few monthly August rainfalls:—1891, 6·48; 1890, 3·79; 1885, 3·16; 1881, 3·55; 1879, 5·33; 1878, 4·49; 1877, 5·84; 1876, 4·37; 1873, 4·81; 1866, 4·69;

1865, 5·33; 1863, 4·01; 1860, 5·78; 1859, 4·35; 1857, 3·02: and 1852, 4·57-inches. The frequency of the wet August months shews the farmer has good cause to grumble, and probably within recent times he had never greater justification than this month.

A glance at the tabulated average rainfalls for 1890 and 1891 shews that we had about 7½-inches less of rain for the first half of this year than we had during the same period last year. The table shews, too, that though July, of 1891, was drier than that of 1890, yet the excess of rainfall for August this year, 2·69-inches over August last year, was so great that the second half of 1891 is, so far, wetter than 1890. During July and August, 1890, we received 7·46-inches; the same two months of 1891, 8·10-inches of rain. We learn, too, that the crops hereabouts have had poured upon them 60·79 gallons of rain per acre more this August than in August, 1890. We cease to wonder at swollen streams, flooded meadows, soddened fields, and sprouted corn with excess of rain. Below is appended table of average rainfalls:—

	40 years' mean.	1890	1891.
January ...	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
June	2·39-ins.	4·17-ins.	2·86-ins.
July	2·60-ins.	3·67-ins.	1·62-ins.
August	3·01-ins.	3·79-ins.	6·48-ins.
Total ...	24·20-ins.	30·03-ins.	23·22-ins.

The monthly mean height of the barometer was 29·83-inches; the mean of the greatest heat in shade during the day, 65·3 degrees; mean of night temperatures, 52·0 degrees. The warmest day was on the 15th, 74 degrees, the coldest night 37 degrees, on the 28th. It is singular that the district, in which the cuckoo is first heard recorded the first frost on the morning of the 30th, when the dahlias and other plants were frost-bitten.

In August, 1791—a hundred years ago—the register bristles with this remark, "good harvest day." Would that I could have truthfully written the same this year. On the 8th early oats were reaped, 15th wheat cut, 22nd corn housed. Pastures were bare, no after grass this season, and the want of grass general. Mushrooms

were very numerous, 1761, 1778, and 1791, were remarkable mushroom years, on the 31st it rained 2·0-inches, and during the whole month 5·3-inches.

September 4th, 1891.

The marked increase of wet which set in during the month of August has been partly maintained this month. True, there were some very hot days, but so soaked were the corn crops that during the cessation of rain they did not dry in some cases sufficiently in the judgment of the farmer to warrant his safely stacking them. And so the harvest time came and went, and even the festivals celebrating the ingathering were held. Yet over many acres, as I saw at the end of the month, the cereals were in arish mows, black and grim, useless, one feared, for food. Oats suffered most, but root crops gained at the expense of the grain crops; yet wheat, taking the country through, thanks to the hot sunshine, yielded fairly, but of inferior quality. It is pitiful that the splendid promises of June and July should have been turned into the comparatively disappointing realizations of August and September. The few fine days of September which wrought such a salvation in the prospects of the agriculturist deserve recording, as meteorological changes soon fade in the memory. The first five days of the month were dry, on the 6th and 7th over half-an-inch of rain fell, followed by a dull day, on which we had a little rain. Then came a real touch of summer! It lasted five days, and closed with a heavy mist on the evening of the 13th, from which it never recovered, though the struggle to be fine continued to the 16th, when it fell away, and soaking rains came on for a week, again followed by another period of five dry days, which were much colder. With a repetition of rain the month went out; 16 days of rain, during which the fall was 3·05-inches; less than an average September rainfall by half-an-inch, but nearly half-an-inch heavier than the rainfall for the same month last year.

Hence the month had three periods of five dry days. The average maximum temperature—greatest heat in shade—was for the 1st period 66 degrees; 2nd, 79 degrees; and 3rd, 66 degrees. That short summer of deep blue sky, 79 degrees in the shade, on one day 101 degrees, and on another 103 degrees in the mid-day sunshine, disturbed by cirrus clouds only in the earlier part of the

day, leave a pleasant recollection, as I spent part of it at sea, when even the porpoises sprang out of the ocean blue enjoying its goodness.

The average monthly maximum heat in shade was 67·2, and the average minimum heat was 51·2 degrees. The mean height of the barometer was 30·0-inches. An exposed minimum thermometer on the 23rd registered 39 degrees. The nights of the 18th, 19th, and 20th, were very stormy and wild. The heaviest daily rainfall was ·49-inch on the 20th. The following are a few heavy September rainfalls:—1885, 6·58; 1883, 5·73; 1882, 4·52; 1876, 5·57; 1875, 5·53; 1874, 5·90; 1871, 8·50; and 1866, 7·88-inches. The rainfall of September, 1891, 3·03-inches, is the heaviest for the same month since 1887, when the rainfall was 3·87-inches.

For reference I append average rainfalls:—

	40 years' mean.	1890.	1891.
January ..	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
June	2·39-ins.	4·17-ins.	2·86-ins.
July	2·60-ins.	3·67-ins.	1·62-ins.
August	3·01-ins.	3·79-ins.	6·48-ins.
September ...	3·49-ins.	2·63-ins.	3·03-ins.
Total ...	27·69-ins.	32·66-ins.	26·25-ins.

We are gradually gaining on the wet year of 1890.

The weather and prospects of 1791—100 years ago—show several coincidences. 11th, thermometer 108 degrees in sun; nuts very scarce. 12th, most of wheat got in in high condition; crops good; barley but slight; oats tolerable. 13th, red after sunset: a mist arises. Not a cloud has appeared upon the sky from the 10th to the 15th. Apples few but fine. 22nd, harvest finished; weather delightfully pleasant to end of the month. A Michaelmas summer. Rainfall for month, 2·40-inches.

October 12th, 1891.

There has been a general desire to know how much rain we have had this month. As I had to lecture at several of the large towns in the North of England during the end of October and first ten days of November, I must ask my readers to forgive the delay of this communication on the subject.

If comparisons were a relief we have had during the last half-century three Octobers on which the rainfall was heavier than October this year—1891, 8·55; 1885, 8·82; 1880, 9·23; 1865, 9·09-inches. But the fact of this month's downfall being classed as one of these exceptionally heavy rainfalls gives it a distinction worth noticing. Perhaps the greatest peculiarity in the rainfall was its cyclonic character—a rush of wind terrific in force accompanied by blinding rain, which descended in parallel sheets. This was the experience in several of the south-westerly counties, and caused an overflowing of streams, flooding of fields, and isolation of houses. In going north I saw several isolations of this character, and, in addition, great inland lakes with timber trees standing in the watery waste. These heavy falls of rain gave a registration in the gauges which is happily not often experienced. On the morning of the 5th we registered 1½-inches of rain in one hour; but Mr. F. H. Davey, in a rain guage at Ponsanooth, registered 2·41-inches during the same time. His rainfall for October is 10·26-inches, nearly 1¾-inches more than at Truro, due probably to the better wooded grounds about, and in some measure to the soil. On October 6th we had nearly two inches, and on the 18th over an inch of rain; from the 10th to the 18th the average daily rainfall was nearly half-an-inch. But none of these records show so high a daily fall of rain as in 1880, when on October the 16th the rainfall in Truro was 3·0-inches.

During the month the rain fell on 25 days, and for 23 of these days it rained consecutively; it was a month, however, of many peeps of sunshine, and the high registration of rain was due rather to intensity of fall than continuous wet. During the month the winds were terrific at times, gales were common, and loss of life saddening. In the last week of the month the barometer had a range of nearly 1½-inches.

The following summary shews our average and that of last year and this:—

	40 years' mean.	1890.	1891.
January	4·85-ins.	5 62-ins.	3·40-ins.
February	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3 90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins
June	2·39-ins.	4·17-ins.	2·86-ins.

July	2·60-ins.	3·67-ins.	1·62-ins.
August	3·01-ins.	3·79-ins.	6·48-ins.
September...	3·49-ins.	2·63-ins.	3·03-ins.
October	4·81-ins.	3·02-ins.	8·55-ins.
Total ...	32·50-in.	35·68-ins.	34·80-ins.

Five and a half inches more rain this October than last; three and three-quarters inches more than the average, and a gradual overtaking of the wet year 1890. The gales were in many cases accompanied by storms of hail, and thunder was not uncommon. On one such night, October 5th, I went down Malpas Road, Truro, when we had a high tide in the river, and the whole of the water was overspread with a phosphorescent light. As the gusty wind caught the water and blew it on as an ever-increasing wave, a fire roll started where the first puff caught the surface, and registered the growing wave in fire. It was a magnificent sight, for the waves broke on the shore in fire flashes, and the spray, seized at times by the fiercer gusts, was blown into the adjoining fields as fire dust. This phosphorescence was due to animal organisms, *Noctiluca*, and other lowly forms of life, and was emitted from the outer layer of the protoplasmic contents of the body; and as we witnessed the vital energy of the organisms transformed into a radiant form, we seemed to be in touch with the latest ideas in light studies, that light is an electric phenomenon, and that vibrations of light are electric vibrations. Probably each of those countless millions of organisms was a battery evolving light, and not chemically working in oxidising tissue.

There has been a general complaint that the wet weather has robbed us of our autumnal glow. My experience has been a generally noticeable greenness on the leaves to the end of the month, and a magnificent display in our southern Cornish woods of soft greens, yellows, and ruddy tints. In travelling one noticed this as particularly intense about Truro, Liskeard, and in the coombes eastward, in South Devon a loss of this effectiveness, and then a re-growth in beauty in North Devon and Somerset, especially in the Vale of Avon. Of course, where frost catches the wet leaves there is little chance of that persistency necessary for the plant contents to change in the leaves, as the frost sheds them in showers of gold. In one short stroll of about two miles out of Truro, I noticed in the last week in October over forty kinds of plants in flower, and we had in our hedgerows many more blooms than we had in

October last year. The starlings, too, were commoner, and on the 26th I saw several swallows. Mr. Matthias Dunn tells me he has never seen so many Northern forms of birds, especially skuas, seeking shelter at Mevagissey as this year.

November 13th, 1891.

The rainfall during the month was a little over half an inch more than the average, the total fall being 5·03; average, Truro, November rainfall, 4·37-inches. We have not to go far back to find wetter Novembers than this one, in 1888 the monthly rainfall was 8·89; in 1883, 6·15; 1882, 5·57; 1881, 5·39 (three years in succession); 1878, 5·78; 1877, 7·09; 1876, 5·47; 1875, 5·80 (four years in succession); 1852, 10·51-inches. Although we have been sensibly overtaking the rainfall of last year during the last three or four months, yet our total registration of wet still leaves 1891 somewhat drier than 1890, though this month has witnessed a rainfall exceeding that of November last year by nearly three-quarters of an inch. Mr. F. H. Davey, in a rain guage at Ponsanooth, has registered 6·15 for the month, as against 5·54-inches last year; this shews a difference this November of 0·61-inch of rain, and nearly agrees with our excess at Truro. The rain fell on twenty days, the heaviest day's fall being on the 10th, 1·19-inches, the barometer being a little over 29-inches, and falling to 28·75 the next morning, when it began again to recover itself. During this fall and rise, three days, we had nearly two inches of rain, heavy hailstorms, and strong winds.

The following is a summary of the rainfall of the last eleven months and those of last year, and an average 40 years' mean for comparison:—

	40 years' mean.	1890.	1891.
January	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5·06-ins.	2·26-ins.
June	2·39-ins.	4·17-ins.	2·86-ins.
July	2·60-ins.	3·67-ins.	1·62-ins.
August	3·01-ins.	3·79-ins.	6·48-ins.

September...	3·49-ins.	2·63-ins.	3·03-ins.
October	4·81-ins.	3·02-ins.	8·55-ins.
November ...	4·37-ins.	4·35-ins.	5·03-ins.
Total ...	36·87-ins.	40·03-ins.	39.83-ins.

The mean of the maxima—greatest heat in shade in day-time—was 51·7; of the minima—greatest cold under cover at night—39·3 degrees; we had frost on six nights; an exposed thermometer registered 12 degrees of frost on the 25th, and there was hoar frost on the same date; we had mist on three days; on the 22nd a slight, and on the 30th a heavy, fog. How little this was in comparison with other places I have had several opportunities of learning.

There is one aspect of the month, I think, rightly follows the above paragraph—the floral aspect. Mr. Davey says on the 24th of November, in a walk through Kennal Vale, he saw 44 plants in bloom; in a short walk near Truro, and not in the most sheltered situation, I saw, at the very end of the month, nearly 40 flowers in bloom. They were surrounded in many cases with spring-like grass, so favourable had the weather apparently been. Some of the peltate or shield-like leaves of the common pennywort were two and a half inches across. Three kinds of coloured flowers were common; I trust to be forgiven for calling white a colour, but it expresses here a distinction. White starworts, pepperworts, wild strawberries, and others; yellow dandelions, potentillas, hawkweeds, etc., and blue and purple blossoms. Now the latter colours are the highest and brightest attractions plants can offer to their insect friends, and hence a ramble which presented red deadnettle, red campion, heather, dove's-foot geranium, herb-Robert, sheep's bit, knapweed, ivy-leaved toadflax, and blue veronica, seemed a time of sunshine and heat rather than, as the calendar says, November, fog common.

A peep backwards; November, 1791, 100 years ago. 2nd—Many flocks of thrushes seen. 6th—Frost powerful. A great many hips and haws. Daisies, and many flowers in bloom. The season mild in general until end of month, when stormy. Fall of rain, 4·2-inches.

December 14th, 1891.

The rainfall at Truro for the year 1891 was less than 1890! Its registration during the month was most exciting, as one felt that every shower might carry over the balance, and stamp a year which had had a February of the very driest kind as wetter than the wet year of 1890. How closely the registration ran may be seen in the total rainfall for 1890, being 45·10; of 1891, 45·05—a remarkable closeness. Generally, too, 1891 was drier than the previous year: the nearness of the total rainfall was caused by the excessive rains of August and October, which were over 8-inches in excess of the same months of 1890.

In 1890 the rain fell on 226 days, in 1891 on 208 days. With the exception of February we have had a wet day on the 8th of every month, and only four times wet on the 5th. The heaviest day's rainfall during the year was on October 5th, 1·93-inches; 1½-inches of this fell in one hour. The rainfall for the month was 5·22-inches, which fell on 25 days; of December, 1890, 5·07; 1886, 7·02; and 1876, 10·59-inches. We have no record heavier than the latter for Truro. Our average December rainfall is 4·65-inches on 20 days.

The warmest day was the 5th, 57; the coldest night was on the 23rd, 11 degrees of frost; on Christmas-eve 10 degrees of frost were registered. The two latter readings were taken from an exposed thermometer. The mean of the monthly maxima, greatest heat in shade, was 51·3; of the minima, the greatest cold in shade, was 39 9-degrees. We had frost on 8 nights. Whilst so many places were in a most lamentable state from the blackest of fog, which hung for days, during which persons walked blindly into rivers and canals and were drowned, and the congested traffic of the railways and streets caused countless accidents, we had a singular freedom, as our only experiences were two slight touches on the 22nd and 25th, which caused but little inconvenience to any one.

We had sunshine on 24 days, gleam—*i.e.*, the sun's disc being visible behind a film of cloud—on 3 other days, sunless days 4.

From the 6th to the 14th the barometer fell and rose nearly one inch, the greatest depression being on the 10th; the weather became wild, thunder, lightning, hail, and heavy rains were experienced, then strong winds and a cloudless sky. We had hoar frost on 3 days.

We notice that the London Correspondent of the *Manchester Courier* asserts that Truro was the wettest place in England in 1890. His idea, apparently, is that wetness is reckoned by the number of days on which rain falls, whilst to meteorologists the quantity measured is the guide, as it is to every civil engineer and farmer. To him Truro was the wettest place in 1890, because rain fell on 226 days. We agree in number, but taking this elementary way of calculating wetness, the following places were surely wetter in 1890. It is not a complete list, but is somewhat distributive:—

Cornwall—Penzance (St. Clare), 263 days; Redruth, 236. Devonshire—Trusham, 256; Chagford, 233; Princetown, 245. Stafford—Uttoxeter, 236. Somerset—Exford Rectory, 263. Lancashire—Bolton, 259. Yorks—Bradford (Stubden), 270; (Doe Park), 269; Settle, 238. Cumberland—Keswick, 251. Westmoreland (Shap), 258; Grasmere, 243. Derbyshire—Woodhead Station, 232. Sussex—Mares Field, 232. Wetter places reckoned by measurement of rain, taking Truro at 45·10-inches; Altarnon, 56·17; Princetown, Devon, 102·07; Duddon Valley, Lancashire, 85 65; Little Langdale, Westmoreland, 115 10; and The Stye, Cumberland, 202·05-inches. The latter is the wettest place in England of which we have any record, and is four and a half times as wet as Truro! The following is a summary of the year's rainfall, of that of 1890, and 40 years' mean for comparison.

	40 years' mean.	1890.	1891.
January ...	4·85-ins.	5·62-ins.	3·40-ins.
February ...	3·38-ins.	1·84-ins.	0·22-ins.
March	2·91-ins.	1·87-ins.	3·90-ins.
April	2·61-ins.	4·01-ins.	2·48-ins.
May	2·45-ins.	5 06-ins.	2·26-ins.
June	2·39-ins.	4·17-ins.	2·86-ins.
July	2·60-ins.	3·67-ins.	1·62-ins.
August	3·01-ins.	3·79-ins.	6·48-ins.
September ...	3·49-ins.	2·63-ins.	3·03-ins.
October	4·81-ins.	3·02-ins.	8·55-ins.
November ...	4·37-ins.	4·35-ins.	5·03-ins.
December ...	4·65-ins.	5·07-ins.	5·22-ins.
Total ...	41·52-ins.	45·10-ins.	45·05-ins.

For 1891 we are three and a half inches above the average.

The rainfalls of 1890 and 1891, taken in Kennal Vale by Mr. Fk. H. Davey, of Ponsanooth, and of St. Agnes for 1891, taken by Mr. Opie, are appended:—

	Kennal Vale.				St. Agnes.
	1890.		1891.		1891.
January ...	7·37-ins.	......	3·23-ins.	......	2·37-ins.
February ...	1·67-ins.	......	·10-ins.	......	·14-ins.
March	1·90-ins.	......	3·25-ins.	......	2·47-ins.
April	3·23-ins.	......	2·35-ins.	......	2·22-ins.
May	5·12-ins.	......	3·37-ins.	......	2·15-ins.
June	4·02-ins.	......	2·98-ins.	......	2·58-ins.
July	4·46-ins.	......	1·89-ins.	......	1·95-ins.
August	4·72-ins.	......	7·34-ins.	......	6·04-ins.
September ...	2·70-ins.	......	3·22-ins.	......	3·95-ins.
October	1·93-ins.	......	10·26-ins.	......	8·41-ins.
November ...	5·54-ins.	......	6·15-ins.	......	4·51-ins.
December ...	4·87-ins.	......	6·70-ins.	......	4·74-ins.
Total ...	47·53-ins.	......	50·84-ins.	......	41·53-ins.

The three chief points of retrospective interest about 1891 are a February summer, a March blizzard, and a drenching wet harvest.

December, 1791—one hundred years ago—7th, violent storms and lightning; 9th, snow, three inches deep,; 12th, snow, eight inches deep; 22nd, surface of ground a continued piece of ice, wind very high; 24th, thunder and lightning. Rainfall for month 4·20-inches.

Our ancestors had an old-fashioned winter. We had in December warmth, sunshine, and many flowers brightening the hedgerows, even the primroses anticipating Spring.

January 4th, 1892.

Obituary Notices.

NICHOLAS WHITLEY was born at Tregony, on March 10th, 1810, and was the eldest son of Mr. Daniel Whitley.

About 1830 he removed to Truro, where he practised as a Civil Engineer, Land Agent, and Surveyor for many years, and in these capacities was well known throughout the West of England.

In 1845 he was appointed Surveyor to the Cornwall Railway, and purchased the whole of the land required for the construction of the main line, as well as that for the St. Ives branch.

He was land agent to Sir William Williams, Bart., for his North Devon Estates, and constructed for him the Heanton Embankments, which enclosed a large quantity of rich marsh lands in the estuary of the river Taw.

He was also land agent for the Hope estates in Cornwall, and land agent and surveyor for the Gilbert estates in Cornwall and Sussex. In the latter capacity he designed and laid out for building purposes a large portion of the town of Eastbourne, and also constructed the necessary roads and sewers.

He was employed by Lord Clinton with regard to Trefusis and other property; Kimberley Park, at Falmouth, was laid out from Mr. Whitley's designs, as also were Arwenack Manor at Falmouth, and Alverton at Penzance. As engineer, he carried out the improvement of the river Camel from Wadebridge to Padstow, and other works in the West of England.

In all matters of business Mr. Whitley was trusted alike for his soundness of judgment, and his strict integrity.

In scientific matters, more particularly geology and meteorology, Mr. Whitley took a deep interest, and by his death the Royal Institution of Cornwall has lost a most useful and valued member, who for more than half a century contributed papers to its transactions, which are comprised in the following list:—

1840. The Cromlech near Pawton.
,, Note on an Elvan Course near Malpas.

1841. Notes on the Geology of part of the Parish of Veryan, Cornwall.

1842. The Agricultural Character of the soils of the Lizard.

1843. Notes on the Geology of the neighbourhood of Perranporth.

1848. On the Remains of ancient Volcanoes on the North Coast of Cornwall.

1850. On some Polished and Grooved Rocks found in Cornwall.

1851. On the Temperature of Rivers.

1855. On the Distribution of Rain in the S.W. of England.

1856. An Inscribed Stone at Nanscowe, St. Breock.

1858. Note on the Braunton Fossils presented to the Museum.

,, The Undeveloped Natural Resources of Cornwall.

1862. Flint Flakes in the drift beds near Baggy Point, Devon.

1864. Flint Implements from Drift.

1866. Recent Flint Finds in the S.W. of England.

1867. Twin Storms of January.

1869. Glacial Action in Cornwall.

1875. Roman Occupation of Cornwall.

1885. Traces of a Great Post-glacial Flood in Cornwall.

1889. The Cliff Boulders of Falmouth Bay, and the Drift Beds on Plymouth Hoe.

1891. Note on the Raised Beach at Pendennis.

He was elected a Secretary in 1859, and served the Institution in that capacity for twenty years; and, after his resignation, he was elected a Vice-President. Mr. Whitley was an Honorary Member of the Geological Society of Cornwall, of the Edinburgh Geological Society, and a Fellow of the Royal Meteorological Society, contributing papers to their Transactions.

In 1843 he published a work on the Application of Geology to Agriculture, and in 1850 his paper on the Climate of the British Islands and its effects on Cultivation, won the prize of £50 offered by the Royal Agricultural Society of England. Of

this paper Professor Pusey remarked in a note appended to it: "This paper appears to me one of the most valuable contributions yet made by science to practical agriculture."

The pages of the Bath and West of England Agricultural Journal contain several papers from his pen, amongst them, is one "On the Temperature of the Sea and its Influence on the Climate and the Agriculture of the British Islands," and another on the "Development of the Agricultural Resources of Cornwall."

In his later years Mr. Whitley turned his attention to the Antiquity of Man and the Palæolithic Age, and wrote several papers on this subject, in which he criticised modern views with much independence of thought and vigour of language.

He died suddenly at his residence, Penarth, Truro, on his eighty-first birthday, March 10th, 1891.

By the unexpected and lamented death of Mr. HENRY MARTYN JEFFERY, M.A., F.R.S., abstract mathematical science has lost one of its ablest exponents, whose long devotion to the special study of the higher branches of pure mathematics has been fully appreciated and honoured by his fellow mathematicians. The loss to local science will, I am convinced, be specially felt by the members of the Royal Institution of Cornwall, who will naturally regret the death of an esteemed Vice-President, whose regular attendance at our annual meetings could generally be relied upon; for in all Mr. Jeffery's intimate relations with the affairs of the Institution, he was ever ready to devote his time, attention, and abilities to its service. He will be sadly missed by us all, especially by those who were attached to him by private friendship.

Mr. Jeffery was the only son of Mr. John Jeffery, of Gwennap. He was born on January 5th, 1826, at the house of his grandfather, the Rev. W. Curgenven, rector of Lamorran, who married the sister of the distinguished mathematician, orientalist, and missionary, the Rev. Henry Martyn, B.D., of Truro, the senior wrangler at Cambridge, in 1801. He was also related to the family of the Rev. Malachy Hitchins, Vicar of St. Hilary, who for more than forty years was the able coadjutor with Dr. Nevil Maskelyne, Astronomer Royal, in the compilation

of the "Nautical Almanac," and one of the observers of the transit of Venus in 1769 at the Royal Observatory. Mr. Jeffery always referred with enthusiastic respect to these well-known mathematical members of his family.

The early years of Mr. Jeffery were, for the most part, passed at his father's home at Gwennap. At the age of seven he was sent to the Falmouth grammar school, where he remained as a pupil during the following seven years. On leaving this school at the age of fourteen, young Jeffery exhibited signs of considerable mathematical and classical ability ; so much so, that he considered himself qualified to offer himself as a tutor in elementary mathematics and classics. There is no doubt that he was, at this time, a most intelligent youth of more than usual precocity. By the advice of some friends, it was, however, resolved to continue his education, and he was sent in 1841 to the Grammar School at Sedbergh, Yorkshire, then under the control of the Rev. J. H. Evans, a Fellow of St. John's College, Cambridge; here he remained till 1845. In October of that year he became an undergraduate at St. John's College, Cambridge ; but he migrated in the following year to St. Catherine's College. In 1849, he graduated as B.A. in the high position of sixth wrangler in the mathematical tripos, and in the second class of the classical tripos. His private tutor, the late Dr. Harvey Goodwin, Bishop of Carlisle, thought highly of his mathematical ability. He remarked that Jeffery was one of the hardest headed mathematicians with whom he had any dealings in Cambridge, and it has been recently stated to the writer by one who is acquainted with his university career, that his position in the tripos, high as it was, scarcely represented his great original mathematical attainments. In 1852, he proceeded to the degree of M.A., and in the same year was adjudged the distinction of first Tyrwhitt Hebrew scholar, which "he gained mainly by his skill in composition, to which his previous classical training (entirely abandoned after his first year of residence) had adapted him."

Soon after taking his degree, Mr. Jeffery accepted in 1850 the post of lecturer at the College of Civil Engineers, Putney, of which the present Dean of Exeter, Dr. B. M. Cowie, was the Principal. In October, 1851, he received the appointment of

second master in Salisbury House School, Edinburgh, under Dr. E. R. Humphreys. Here he remained only a few months, in order that he might have sufficient leisure to prepare for the Tyrwhitt Scholarship examination. Dr. Humphreys, who in 1852 became Head Master of Pate's Grammar School at Cheltenham, was so favourably impressed by the scholarly ability of Mr. Jeffery, that, on his recommendation, his former colleague was selected by the President and Fellows of Corpus Christi College, Oxford, to be the second master in the school. Sixteen years afterwards, on the resignation of the Rev. Dr. Hayman in 1868, Mr. Jeffery was appointed to succeed to the vacant Head Mastership, a position he retained with success until his retirement on a pension in 1882. On leaving Cheltenham he took up his residence at Falmouth, so that he might be able to have the personal management of a considerable freehold property in that town and neighbourhood, which he had inherited from his father. Many of his pupils educated at Cheltenham, have expressed their indebtedness to his careful teaching for their after success in life, some of them having obtained high distinction at the Universities, and in various competitive examinations for admissions into the public service.

It is, however, as a pure mathematician that Mr. Jeffery's name will be remembered in English science. At the meeting of the British Association for the Advancement of Science, held at Cheltenham in 1856, Mr. Jeffery acted as one of the local secretaries, and it has been truly said that the public discussions on this occasion first developed his latent energies, and created in his mind a strong inclination to enter into original mathematical research. At this meeting he contributed two important papers "On a Theorem in Combinations," and "On a Particular Class of Congruences." With these papers he commenced the long and continuous series of investigations in pure mathematics, which have enriched the pages of the principal mathematical journals from that year to the present time. His most important memoirs have been on pure analysis and analytical geometry, especially the classification of class-cubics, both in plane and spherical geometry. A similar classification for class-quartics have also occupied his attention. The following titles of a few of his researches will give some idea of the general character of

the abstruse investigations in which he took so much interest:—"The Spherical Ellipse referred to Trilinear Co-ordinates;" "Cubics of the Third Class with Triple Foci, both Plane and Spherical;" "Spherical Class Cubics with Double Foci and Double Cyclic Arcs;" "On Sphero-Cyclides;" "On the Generalised Problem of Contacts;" "On the Converse of Stereographic Projection, and on Contangential and Coaxal Spherical Circles;" and "On the Genesis of Binodal Quartic Curves from Conics." To the investigation of class-cubics, both plane and spherical, Mr. Jeffery devoted his intervals of leisure for four years (1876-1880), and published the instalments, as they were completed, in the "Quarterly Journal of Mathematics." Mr. Jeffery had a strong desire to prepare a text-book on his favourite subjects, and he had made some progress in the work; but alas! the copy is far too incomplete to be of use, excepting as a record of the studious activity of his life to the end, and of his great mathematical talents. As a proof that his mental powers were as active as ever, I have been informed that only a few weeks before his illness, he forwarded to the London Mathematical Society an important paper on the classification of binodal quartics, which was read at the monthly meeting of that Society, on November 12th, nine days after his death. This communication closes the long line of Mr. Jeffery's papers, most of which have appeared in the "Quarterly Journal of Pure and Applied Mathematics," the "Proceedings of the London Mathematical Society," the "Reports of the British Association," the "Proceedings of the Royal Society," and other Scientific Journals.

In addition to the non-mathematical writings of Mr. Jeffery contained in the "Journal" of the Royal Institution of Cornwall, he contributed to three classical works of Dr. Humphreys; (1) sixty short introductory exercises to "Exercitationes Iambicæ, or progressive exercises in Greek Iambic verse; and (2) Appendixes to "Lyra Hellenica, or translations in Greek," and "Manual of Greek and Latin prose composition." At the Social Science Congress held at Cheltenham in 1878, Mr. Jeffery read a paper "On the best means of connecting Primary and Intermediate Education;" and in 1890 he privately printed "Extracts from the Religious Diary of Miss Lydia Grenfell," in

which he has extracted all the references in the diary relating to the Rev. Henry Martyn, and also those giving indications of Miss Grenfell's life and conversation. A verbatim copy of the complete diary was presented by Mr. Jeffery to the Library of the Royal Institution of Cornwall.

Since Mr. Jeffery has been residing at Falmouth, he has taken a great interest in the management of the Royal Institution of Cornwall, and of the Royal Cornwall Polytechnic Society, in both of which he has served as an honoured Vice-President. He was also a valued contributor to their Journals. It is somewhat remarkable that so abstruse a mathematician should take so much interest in archæological and topographical history, but we have only to refer to his printed contributions in the Journal of the Institution to prove that his mathematical mind could be brought advantageously to bear on the elucidation of local history, as well as on abstract science. Mr. Jeffery was one of the Secretaries of the Meteorological Committee of the Royal Cornwall Polytechnic Society, and of the Falmouth Observatory, in the success of which he has taken a great interest since its erection in its present position. He was always ready to give most valuable assistance to the superintendent in the initial difficulties of the magnetograph work, a department of the Observatory to which he paid a constant personal attention. Mr. Jeffery also took a considerable interest in the management of the Falmouth Grammar School.

Mr. Jeffery was elected a Fellow of the Royal Society on June 3rd, 1880. He was also a member of the British Association, and of the London Mathematical Society. It was a great delight to him to spend a few weeks in London each year, and he usually chose the months of May or June, so that he might enjoy the pleasure of meeting with his scientific friends at one of the two annual soirées of the Royal Society.

During the last three or four years, Mr. Jeffery has occasionally complained to me, as his intimate private friend, of being subject to much uneasiness, caused by some internal complication, from the effects of which he was frequently troubled with insomnia. But still he remained active and apparently well to the last, often walking from Falmouth to Truro, and even greater

distances, without much fatigue. When I was his guest in June last, he appeared to be in a better state of health than usual, but a few weeks before his death his complaint became much exaggerated, necessitating one or more surgical operations. He thoroughly broke down on October 20, when he had to take to his bed, and after much suffering he sank gradually. On the day preceding his death he became unconscious, and in this condition passed away peaceably at 9.30 a.m., on Tuesday, Nov. 3rd, 1891, in the sixty-sixth year of his age. Three days afterwards, his remains were interred in the family vault, with his father and mother, at Gwennap.

It is very gratifying to the friends of Mr. Jeffery that his well-known features will be preserved to us in a fine enlarged photograph, which has been kindly presented to the Institution by his aunt, Miss Curgenven, of Falmouth. This portrait, by Maull and Co., of London, is a beautiful work of art, and will be an interesting addition to the valuable collection of portraits of the Presidents and other officers and friends of the Institution, which now adorn the walls of the library and museum. Miss Curgenven has also presented to the library of the Institution an important series of scientific works, formerly belonging to Mr. Jeffery, including a number of volumes of the "Philosophical Transactions" and "Proceedings" of the Royal Society, "Reports of the British Association," "Proceedings of the London Mathematical Society," the "Collected Mathematical Papers of Professor Cayley," and many other valuable works, a list of which will be given in a future number of the Journal. Such an important collection of standard works cannot fail to add greatly to the scientific value and general usefulness of the library of the Royal Institution of Cornwall, and this handsome present from Miss Curgenven will doubtless be highly appreciated by the members.

EDWIN DUNKIN, F.R.S.

NOTES AND QUERIES.

The Editor will be glad to receive short Notes on Discoveries, and occurrences of interest, relating to the Antiquities, Geology, and Natural History, &c., of the County, for insertion in this portion of the Journal.

Cornish Crosses.

From time to time some of these monuments disappear, and the task of tracing them is very often a difficult one. It is also equally difficult at times, to find out from whence a cross came, which one sees displayed in a private garden. Having been unable to ascertain particulars about some of them, I should be grateful to the readers of this Journal if they could give me any information respecting the crosses given below.

Is it known what has become of the following crosses?

Camborne. Formerly on the top of a wall at Treslothan. It has the figure on the front and a cross on the back.

Cardinham. Blight, p. 84. "A cross about 6-ft. long, forms part of the bridge over a small stream between the well and the present church."

Cury. I was once shewn a sketch of a short round headed cross set in a circular base and was told, "it was three miles from Cury."

Laneast. Formerly in the churchyard, but removed within the last few years.

S. Keverne. Blight, p. 58. "A mutilated cross at S. Keverne church town, &c."

S. Columb. Blight, p. 66. "A cross by the road side between Higher and Lower St. Columb." Would this road be Treskey's Hill? The stone is also mentioned in the Parochial History of Cornwall.

S. Cleer. Blight, p. 67. "A cross between Redgate and S. Cleer (see Report of Roy. Inst. Cornwall, 1851)." Blight illustrates the Longstone near the Hurlers, so these cannot be the same crosses, though they are similar in type.

Southill. Blight, p. 66. "In the grounds of the Rectory, Southill, (a cross) similar to that at Higher Drift. This stone is illustrated by Kingston.

Broadoak. Britton mentions a cross at "Broadoak or Bradock, near the Church called Killboy Cross." It is illustrated in Gentlemens' Magazine, 1805, and Catholic Miscellany, 1827.

Lanivet. A note and illustration in the last named Journals says, "Called Re Perry cross, stands by the road side between Lanhydrock and Lanhivet, (*sic*) height 3-ft. 11-in.

Is it known where these crosses came from?

S. Day. Two crosses in the grounds at Tregullow. Also one at Scorrier, which has the figure upon it.

Mawgan in Meneage. A round headed cross over a gateway at Trelowarren.

A. G. LANGDON,
Craven Street, London, E.C.

St. Rumon's Cross.

Not far from the ancient site of St. Grade church, is the old-fashioned village of St. Rumon. Here, early in the sixth century, dwelt St. Rumon, one of the many Irish Saints who came into Cornwall, having a cell for his habitation, and a chapel for his devotions.

Of the hermitage and the oratory, no remains can now be traced, but the site of the latter can be identified. There is on St. Rumon estate, a field still called Chapel Field. Through it the old church path from Kuggar to St. Grade church formerly passed; and in the south-western corner close to a little trickling stream, the chapel of St. Rumon undoubtedly stood. Not marking the site of the chapel—yet in the same field, is the ancient Cross of St. Rumon—a rude pillar of serpentine, on which a simple cross is still faintly visible. Its southern face is 2-ft. 10-in. high; the shaft is 10-in. wide at the base, and 11½-in. at its junction with the disk, the latter being 1-ft. 4-in. in diameter. The cross is evidently of the Latin type, the limbs being raised from the surface and extending in each

direction about 4-inches. Its outline has been so much altered by exposure to the atmosphere, as to be barely discernable, but its situation, coupled with the tradition of the villagers and the statement of an old man who remembered that it was known as St. Rumon's Cross more than sixty years ago, gives it an importance that it would not otherwise claim. Search was made for its base quite recently, but without success.

Dedication of Cury Church.

No record which refers to the dedication of the parish church of Cury has been found. It is true that the *Parochial History of Cornwall, Lake's guide to Helston and the Lizard District, and the Churches of Cury and Gunwalloe*, alike mention as a fact that Walter Bronescombe, Bishop of Exeter, dedicated the church to St. Corantyn, on Sept. 1st, 1261. But this is obviously a mistake, for on referring to Bronescombe's *Episcopal Register*, edited by Prebendary Hingeston-Randolph, it will be seen that the Devonshire church of Coryton was dedicated on that date. Moreover on the following day, Sept. 2nd, 1261, the Bishop dedicated the church of Bradestone, which would have been impossible, had he been as far west as Cury on the previous day. The mistake must be attributed to the late Dr. Oliver, who was not unfrequently inexact in his reading of the contracted engrossing hand in which the earlier Episcopal Registers are written.

The Wendron "Nine Maidens."

The *Schedule of Prehistoric Monuments*, prepared in 1879 for the Society of Antiquaries, is not quite accurate, in reference to the Wendron Circles. The Plan drawn to scale, shews five stones standing erect, and a displaced stone at the edge, whereas there are six erect stones still *in situ*. The monolith not included in the plan, is partially enclosed within a hedge. It is 8-ft. 6-in. east of the displaced stone, and 20-ft. north-west of the upright stone nearest the hedge as shewn in the plan. Like the other stones, it is a single block of unhewn granite; it

measures 4.ft. 4-in. in height, and 11-in. in width at the top. The enclosure, in which the Circle now stands, formed a part of the well-known Nine Maiden Downs till about the year 1865, when the hedge which now partially hides from view the stone which has escaped the notice of Mr. Lukis, was erected. Hals speaks of nine stones as "still to be seen" in his time; Dr. Borlase mentions eight stones as "still standing," *circa* 1760; and the Rev. C. Lukis tells us that in 1879 there were "five standing stones and a displaced stone," *i.e.* six altogether. It will be interesting, however, to know that only one stone has actually disappeared; the remaining eight being "still extant."

J. WILLS.

Mr. Haverfield, of Oxford University, who during a visit to the Museum last summer was much struck with the inscription on the Pozo Stone being in full marked figures, writes me saying that he "saw lately in the Rotunda in Vienna, some rock markings brought by Dr. Holub from Central Africa, which were similarly inscribed. The whole surface of each animal or figure being picked out with small chippings; the places are so far apart that there is probably no connexion, but the coincidence of method is very curious."

Last March, Mr. F. H. Davey, of Ponsanooth, sent to the Museum a beautiful specimen of a Male Brambling, *Fringilla montifringilla*, L. We have in Cornwall good reason to remember that month and its blizzard, and this little record bears on the latter. This bird and others in hundreds, came round Mankey Farm, Ponsanooth, with the commencement of the storm, they swarmed in the farm buildings, tearing the straw abroad in search after grain, and were so tame as to be knocked over with sticks. As the snow disappeared, most of them went away, but scores were content to stay a week or two longer.

Recently, when remounting in the Museum a mummy Ibis—*Ibis religiosa*, Cuv.—given in 1870 by Mr. G. F. Remfry, the head of a young Crocodile dropped from inside the bird. The

specimen illustrates a time when the Ibis was held in the greatest veneration, when a pyramid, Sakkara, was dedicated to it, and when these birds were embalmed in the same spices as the Egyptian kings; a period over two thousand years ago. The incident is of interest, since it shews amidst the sacred regard which enshrouded it, that the food of these birds was the same as it still sometimes procures in the upper reaches of the Nile. It is now very rarely seen in Egypt.

H. CROWTHER.

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The Council of the Royal Institution of Cornwall desire that it should be distinctly understood that the Institution as a body is not responsible for any statements or opinions expressed in the Journal; the Authors of the several communications being alone answerable for the same.

Royal Institution of Cornwall.

SPRING MEETING.

The Spring Meeting was held on Tuesday, May 31st, at the rooms of the Institution.

The chair was taken by the President, Sir John Maclean, F.S.A., who delivered his address.

Archdeacon Cornish proposed a vote of thanks to the President, and also moved a resolution "That it is desirable, in the opinion of this meeting, that a Record Society for Cornwall be formed for the printing of historical documents relating to the county, and that the Council of the Institution be desired to consider what steps should be taken to establish and maintain it."

This was seconded by Mr. J. C. Daubuz, and carried.

A paper was then read on "Cornish landowners, temp. Edward I," by the late W. Sincock.

On the motion of Canon Donaldson, seconded by Mr. Michell, a hearty vote of thanks was passed to the authors of papers, and donors to the museum and library.

ADDRESS BY THE PRESIDENT,

SIR JOHN MACLEAN, F.S.A., F.R.S.A. (Irl.)

V.P. Royal Archæological Inst. Great Britain and Ireland, &c.

The subject I have selected upon which to address you this afternoon as President, will not, I fear, afford scope for such scientific and brilliant effusions as you have been accustomed to hear delivered from this chair by my predecessors; nevertheless, the subject, though modest in its character, is one of very great importance. It is "The sources from which materials may be drawn, and evidence obtained, for writing a New History of Cornwall upon a wider and more accurate basis than that which is afforded by what are now considered the standard histories of the county." This New History is a work greatly needed. My address will be a sort of sequel to one I delivered, close upon 20 years ago, at Exeter, from the Presidential chair of the "Historical Section of the Royal Archæological Institute." But, as D'Israeli once said, "many things have happened since then," and in nothing, surely, have greater changes appeared than in the opening out of archives, both public and private, for the study of history both general and local.

The writer of history should approach the subject with an open mind, repressing all temptation to prejudice. An author who writes to support preconceived notions does not write *history*. This was the case with Macauley. His style was beautiful, clear, charming, and carried the reader along with him, but, unfortunately, his works cannot be relied upon as history. Such, also, was the case with an eminent friend of my own, now alas! departed. There is also one other caution I would venture to mention. We should not, either in reading or writing, look at circumstances, or the feelings and actions of persons in the 12th or 13th centuries through our spectacles of the 19th, but endeavour to place ourselves in their positions as regards their feelings, religions—prejudices, if you like, and degree of culture. Unless we do this we can scarcely be impartial.

A writer of history should quote, very specifically, his authority for every statement of fact he makes, and verify every quotation of others before he uses it. This will enable him to avoid many pitfalls which a too careless following of others might lead him into. Many, so-called, authorities which you see cited in foot notes often fail to support the statement in the text. If this be the case unhesitatingly reject the statement. Writers of history, so-called, are very prone to follow each other like a flock of geese. This is the way in which many egregious historical errors are perpetuated.

We have adverted above to the great advantages which, of late years, have been afforded to historical students. It must not, however, be supposed that this lightens their labours. On the contrary, it has greatly increased the responsibility of a conscientious writer. It gives him a wider field for research—History is a coy damsel, and to be won must be wooed patiently and persistently.

With your permission, I will now proceed to offer a few observations as to the sources from which a student of the history of Cornwall should seek accurate material for his purpose, and I shall not lead you back to pre-historic times. Much has been said for antiquities of those times by my friend Mr. Iago. Domesday book is early enough for local modern history. And in offering these remarks I must beg it to be understood that I by no means put myself forward as a teacher. There are many among you, I doubt not, better acquainted with the subject than myself. I am but a humble student like yourselves seeking after truth.

The sources of local history are innumerable, but for the present purpose they may be roughly divided into two classes; *Local* and *External.*—By *Local*, of course, is meant documents, both in print and in manuscript, existing in the county; and by *External* similar documents to be found elsewhere.

As to the former class I should, of course, first mention the County Histories, and what can we say of these except that they are woefully deficient in exact historical knowledge, and that steps should be immediately taken to prepare a history worthy

of the county; and the first step should be the preparation of a scheme, and the collection of materials for carrying it out.

For me to comment in detail upon the various Histories of Cornwall would be presumptuous and unnecessary. It has been done by a gentleman far better qualified than I am for the task. The late Mr. Davies-Gilbert, in the preface to his "Parochial History of Cornwall," published in 1837 in 4 vols. 8vo, gives a brief bibliographical description of each of the then existing Histories of the County. I must, however, crave permission to call attention to an incident in illustration of the admonition, which I ventured to give above, as to the necessity for an author before using extracts made by a preceding writer, however illustrious he may have been, to verify them. I conclude that all here are acquainted, more or less, with that quaint, interesting and most charming work, Carew's "Survey of Cornwall." and they will probably recollect that the author has printed pp. 39-53 (Ed. 1769) from the well-known "Red Book of the Exchequer," and other documents of the same character but of later dates, the Returns of Knights' Fees in Cornwall down to the 3rd Henry IV. Many years ago, however, when engaged in a work on Cornwall, I referred to these Returns in Carew's Survey; I found them unintelligible, and on collating my copy of Carew of 1769 with the originals in the Record Office, I found the printed book grossly inaccurate. The question then arose as to the accuracy of the first edition of the Survey of 1602, and upon examination I found that it agreed literally with that of 1769, and, moreover, that the last edition by Lord DeDunstanvill, 1811, possessed the same faults. I do not presume to say from what cause this accident occurred. We all know that Carew was an accomplished scholar, and I can only suppose that he entrusted someone to make the transcripts for him who was unable to read the documents, for it is inconceivable that they are undetected printer's errors. But the still more remarkable fact is that, in the various editions through which the work has passed during close upon 300 years, the errors have been printed literally as they stood in the Survey of 1602. We can only conclude that Mr. Carew, being known to be a well qualified author, subsequent writers trusted him and followed him into the mire. This is a caution which all authors, if they regard their own credit, would do well to observe.

A new History of Cornwall by an anonymous author has been published, since Mr. Davies-Gilbert wrote in 1837, entitled "The Complete Parochial History of the County of Cornwall." It is known as Lake's History, from Mr. Lake, of Truro, the publisher. It is stated on the title page to have been compiled from the best authorities, and Lysons and other authors, with all their errors, have been faithfully followed. No attempt has been made, so far as appears, at independent research. Nevertheless it is a useful work, as the compiler has printed the monumental inscriptions existing in the various churches, but, like every other record, they, of course, require verification.

I must not forget to mention the excellent work done by this Institution from the date of its foundation in 1818, as well in Science as in Local History. It is equalled by few and surpassed by none. Its Annual Reports for the first 40 years of its labours, and its Journal since 1864, contain matter of the highest value to historical students—but its usefulness is greatly marred through the want of a good general index, which ought to be supplied without delay. This, I think, is one of the first works to be taken in hand.

Cornwall, fortunately for her, through the labours of two of her gifted sons, Messrs. Boase and Courtney, possesses in the "Bibliotheca Cornubiensis" an admirable guide to all the printed historical literature of the county, and by reference to this valuable work, a fellow to which I believe is not to be found in any other county, together with the "Collectanea Cornubiensia" of Mr. G. C. Boase, will suffice I think for all practical purposes, as far as printed books are concerned. I will, therefore, turn to the consideration of some of the manuscript materials to be found in the county.

First in importance among those manuscript records we must place the Parish Registers of baptisms, weddings and burials. These registers are of the highest value to all classes of the community, especially to the middle and lower classes, though the succession to many peerages have been proved by them, yet have these records from the day of their institution in 1538 to almost our own time, been treated with the greatest carelessness and neglect.

The first official order for the institution of Parish Registers was in the injunctions of Thomas Lord Cromwell, dated 29th Sept. 1538. This person had been appointed by the king in July, 1535, his vice-gerent in all affairs ecclesiastical, and created Baron Cromwell 9th July, 1536. He was further advanced to the Earldom of Essex, 10th April, 1540, and attainted and executed the same year. There must, however, have been some rumour, suggestion, or intimation of what was intended in the earlier part of Cromwell's authority, for great apprehension and discontent prevailed throughout the country from Yorkshire to Devon and Cornwall, prior to the issue of the formal order. This was manifested by the fact that the leaders of the northern rebellion, called the "Pilgrims of Grace," in 1536 placed in the forefront of their grievances that some new tax was intended in addition to those by which they were already oppressed: "that infants should not receive the blessed sacrament of baptism onlesse an trybitte be payd to the kyng." Cromwell was too cautious and prudent a man to increase the king's difficulties by an act which would strengthen the hands of the rebels,then numbering 40,000 well-armed men in the field, which already alarmed the stout heart of the king. Consequently the injunctions issued in 1536 did not contain any order on the subject of the Parish Registers. That was shelved for the moment.

The excited condition of the people of Devon and Cornwall is shewn by the following holograph letter of Sir Piers Eggecombe addressed to Cromwell, to whom Sir Piers says it was specially sent by his own trusty servant: Sir Piers was sheriff of Cornwall in 1535.

"Plesse it your goode Lordeshyp to be advertyssd that the kynggs majesty hath commandyd me, at my beynge in hys gracius presens, that in casse I parceyvyd any grugge, or myscontentacyon a mooge hys sojectes, I shulde ther off advertysse your Lordeshyp by my wrytynge. Hyt ys now comme to my knolegge, this 20 daye of Apryll, by a ryght trew honest man, a servant off myn; that ther ys muche secrett, and severall communycacyous amongges the kynge's sujettes; and that off them, in sundry places with in the scheres off Cornwall and Devonsher, be in great feer and mystrust, what the kynggesasfasdf

hyghnes and hys conseyll schulde meane, to geve in commaundement to the parsons and vycars off every parisse, that they schulde make a booke and surely to be kept, and wher in to be specyffyyd the namys of as many as bee weddyd, and the namys of them that be buryyd, and of all those that be crystynyd. Now ye maye perceyve the myndes of many, what ys to be don to avoyde ther uncerteyn conjecturys, and to contynue and stablysse ther hartes in trew naturell loff, accordynge ther dewties, I referre to your wyssdom. Ther mystrust ys, that somme charges, more than hath byn in tymys past, schall growe to theym by this occasyon of regestrynge off thes thynggés; wher in yff hyt schall please the Kyngg's Majeste to put them yowte off dowte in my poar mynde schall encresse moche harty loff. And I besseche our Lord preserve you ever, to hys pleasser, 20th, day of Apryll. Scrybelyd in hast."

"To my Lorde Privy Sealeys Lordesshyp, be this gevyn."

(Signed) P. EGGECOMB.

(Cromwell's Correspondence in Chapter House, Bundle E).

The letter wholly in Sir Pier's handwriting.

Irrespective of this open expression of discontent, a passive resistance was offered to the acceptance of Cromwell's injunction. The order was only very partially obeyed, and it had to be repeated from time to time for many years; *e.g.*, in 1547, in 1557, and again in 1559, in more stringent terms. Probably this last was more effective, for we find that a great many registers commence about the date of the accession of Queen Elizabeth. In Cornwall the registers of one parish commence as early as 1516. This was St. Michael Penkivell, and it may be accounted for by supposing that the great family of Carminow, which then dominated the parish, possessed some notes of baptisms, marriages, or burials, which, when the new registers were introduced, were transferred to them. Twelve other registers in the County commence between 1538 and 1541; 32 others begin between 1542 and 1560, of which 16 were introduced in the first three years of Elizabeth's reign. Of the remaining forty years of her reign an addition of 33 more was made; but it must be borne in mind that we are dealing with the existing registers only. Some of them probably are imperfect. There may have

been an earlier volume in some of the sets which may have been lost, but it is unlikely that many have been lost earlier than the time of Queen Elizabeth.

Nothing further of any consequence took place with reference to parish registers until 1597. On the 25th Oct. in that year the clergy in convocation made a new ordinance respecting the registers, which was formally approved by the Queen under the great Seal. This was afterwards embodied in the 70th canon of 1603, which canon has not been repealed, and is still in force. This ordinance directed that every minister at his institution should subscribe this declaration:—" I shall keep the register books according to the Queen's Majesty's injunctions;" and further it was ordained that every parish should provide itself with a parchment book, in which the entries from the old Paper Books should be fairly and legibly transcribed, each page being authenticated by the signatures of the minister and church-wardens. Moreover, very particular directions were given for the safe custody of the Register Books, and for further security against loss it was ordered that a transcript should be made of all the entries in each year, and be transmitted to the Bishop within a month after Easter, to be preserved in the Episcopal Archives; and for still further security the Canon provided that if the minister or the churchwardens shall be negligent in the performance of any thing herein, it shall be lawful for the Bishop, or his chancellor, to convent them as contemners of this constitution. Alas! where are transcripts now. Whether this Canon may be binding or otherwise on the laity, I say not, but that it is binding on the bishops and clergy is unquestionable. These transcripts, if carefully preserved, would be of inestimable value. They have proved so in many instances. They have prevented the most glaring attempts at fraud, and have turned the scale in many peerage cases. May I be permitted to mention two or three examples? In the claim of Charlotte Gertrude M'Carthy, in 1825, to the Stafford Peerage, an attempt at fraud was suspected. the Bishop's transcripts were called for, and a forgery n the original discovered. In the Angell case, where an agricultural labourer established a claim to property valued at a million sterling, the Attorney General obtained a rule nisi for a new trial on the ground that the registers produced in court had

been tampered with, as was proved to be the case by comparing them with the transcripts. The original entry of the burial of "Margaret Ange" had been altered to "Marriott Angell." In the Leigh Peerage case, the agent opposing the claim had searched the original registers at Wigan for a certain baptism, without success, there being a general chasm at the period, 1658. When the House of Lords had nearly concluded the hearing, the agent wrote to the Bishop's Registrar at Chester. The letter arrived at a little after eight o'clock in the evening of the 4th June, 1829. The search was made, the baptism found and communicated, and the case concluded against the claimant.

The regulation made in 1597 and 1603, was as far as human foresight could devise, all that was needed for the safety of these invaluable records, and to supply, as far as practicable, a substitute for the original registers in the event of their loss by fire or any other unavoidable accident. But what was the result of this excellent ordinance? Did the ministers and churchwardens contemn the Canon? I think not. In answer to my own question, I must ask your permission to say a few words based on my own experience of this deplorable matter. Some 25 years ago I was desirous of completing, as far as practicable, my extracts from Cornish Parish Registers, and went to Exeter for that purpose. I found then, from Mr. Burch, the Deputy Registrar, and the gentlemen serving under him, the greatest courtesy and assistance, for which I shall always feel most grateful, but the result of my visit will be best shewn by an extract from my note book made on the spot on 12th Sept., 1868.

"These transcripts extend from the year 1597, but I found them in the worst possible condition. The greater portion prior to the year 1700 are completely lost. They were, apparently, returned in Deaneries and filed on common cord, by which they were suspended on pegs. The cords became rotten in the damp tower in which they were placed, and the transcripts fell down on the floor and got mixed together; many, as stated above, were entirely lost, and of those that remain many are so rotten that the writing is illegible, and they will scarcely bear a touch. Of a large number the head is rotted off so that the name of the parish and date are gone, and the only means of identifying the

parish to which they belong is by ascertaining of what parish the subscribing clergyman was incumbent; and moreover they are all mixed together for all parishes in the diocese. They appeared to me to have fallen down promiscuously on the stone floor, and had lain there for a considerable time, and been walked over by persons whose business took them into the room, until some one, of a somewhat greater spirit of tidyness than his predecessors, gathered up and tied them in crumpled bundles, like bundles of hay. I spent several days in smoothing them out and tying them up in bundles in some measure flattened, but not having a press I was not very successful. I did not make any attempt at a classification, except that during the last few days I endeavoured to separate them under the two counties of of Devon and Cornwall."

I am very sorry to add that this is not an isolated case. The transcripts in the other Episcopal Registries in the West of England, *e.g.*, Hereford, Worcestor, and Gloucester, are comparatively few. Bristol has escaped the shame, because all her Episcopal Archives were burnt, together with the Bishop's Palace, in the riots in 1832. What has been the cause of this neglect of the Registers? Did the ministers and churchwardens contemn the Canon. I do not think so, for I have noticed in the churchwarden's accounts from time to time, trifling charges for writing the transcripts. I am afraid we must come to the conclusion that the blame must rest upon the carelessness and neglect of the Bishops and their chief officers.

I afterwards discovered that a great many of the transcripts relating to the Cornish parishes exist in the Archdeaconry Court at Bodmin, which, in some measure accounts, for the paucity of the returns in the Bishop's registry, where, under the Act of Parliament, they ought all to have been deposited. They had probably been delivered in at the Archdeacon's Visitation, and had not reached any further. These also, I am sorry to say, are in a very bad condition, though they have not been treated with such gross neglect as have those in the Episcopal registry. As regards the records in the Archdeaconry Court, I would refer to the excellent description of them by the Rev. W. Iago, printed in the Truro Diocesan Kalendar for 1882, p. 69. From this description all necessary information may be readily obtained.

I would next refer to the Parish Accounts, both of the churchwardens and the overseers of the poor, and likewise to the Vestry Books. The accounts here mentioned have been treated even worse than the parish registers, for, in many instances, they have been regarded simply as waste paper. Where they exist, however, of early date, they contain much valuable and interesting information upon parochial polity, and are illustrative of the social condition, manners and customs of our forefathers in not very distant times.

Then as concerning Wills. You are aware that considerable alterations have been made, as in many other things, with regard to the Probate of Wills within the last 60 years. All jurisdiction respecting wills before that time was vested in the church, and in addition to the Provincial Court of Canterbury and the Diocesan Court of Exeter (I shall confine my remarks to Cornwall), there were divers other local jurisdictions in this matter. In Cornwall there were 206 Old Parishes which fell into the following jurisdictions respectively, viz: 176½ belonging to the Archdeacon, 26½ (Padstow was the divided parish. The urban portion of the parish belonged to the Archdeacon, and the rural to the Bishop) Peculiars vested in the personal jurisdiction of the Bishop and in certain Deans and Chapters, and three parishes in the Deanery of St. Burian, viz: St. Burian, St. Levan, and Sennan, which were under the jurisdiction of the Dean of that collegiate church which had existed from a period prior to the conquest, and that jurisdiction, as regards the proof of wills, continued until quite recently. The Wills proved in this Deanery are now deposited with the Archdeaconry Wills at Bodmin. It should be observed, however, that in all cases in which the testator bequeaths money or goods of the value of £5 or over in another diocese, the Will must be proved in the court of the Province, and that during the Bishop's Visitation the Wills of all persons dying within the Archdeacon's jurisdiction must be proved in the Diocesan Court; and the Wills of all beneficed clergymen, not having *bona notabilia*, must be proved in the same court. The Rev. John Wallis, Vicar of Bodmin, whose father was registrar of the Archdeacon's Court, writing in 1838, states that there were then 70,000 Wills carefully preserved in the Registry.

Among the records of the Archdeaconry Court there exists documents reaching down, I think, to the present century, shewing that the church still exercised discipline for the correction of morals by public penance and absolution.

Before I leave spiritual questions, there is one other matter of a spiritual nature about which I must not omit to say a few words. I allude to the collation and institution of Clerks to benefices. When I commenced the study of local history in this county, some 30 years ago, the succession of the Incumbents of Parishes was one of the first matters that attracted my attention. I found there were few advowsons of Parish Churches that were held in what is called *in gross*, that is independent of the manors in which they were situated, but that, generally, the advowson was appurtenant to the manor, so that the lord of the manor possessed also the patronage, and presented to the church. This gave me a clue to the devolution of the manor also. But the task of obtaining information upon this subject at that time was a work of great drudgery. The Bishop's Registers, in which admissions to benefices were recorded, consist of many great Leger Books, of considerable weight, extending from 1257 down to the time of Henry viij. Besides the institutions, &c., of Clerks, there are many other things recorded in these volumes, *e.g.*, many original charters, some of them pre-Norman, copies of Bulls, Inquisitions, Interdictions, Sequestrations, Licenses for Chapels or Oratories in manor houses, Marriage Licenses, Dispensations of various kinds, &c., &c., and not a few ancient Wills. But after the time of Henry viij these registers were limited to admissions to benefices. The drudgery of wading through these enormous volumes, page by page, some parts written in a small cursive hand, much and variously contracted, some badly indexed and some not indexed at all, may be conceived. A flood of light, however, within a few years past, has been thrown upon this apparent chaos by my learned and esteemed friend the Rev. Prebendary Hingeston-Randolph. He has commenced the gigantic task of making an analytical index to each of these stupendous volumes, and has completed the registers of Bishop Bronescombe, from 1257, and Bishops Britton, Quivil, and Stapledon, and also of Bishop Stafford, so that all the information contained in those bulky volumes is ready at the student's hand,

without lifting a cover. All students owe a debt of gratitude to Mr. Randolph greater than I can express. No such work has been undertaken, so far as I know, or is likely to be undertaken in any other diocese in the kingdom.

In 1558, another series of registers was established called "Act Books," containing a variety of information excluded from the registers proper. They contain licenses to marry, to practice medicine and surgery, to keep school, and a variety of other matter of more or less interest.

There are also deposited in this office Perambulations, and Terriers of ecclesiastical lands, and Inventories of church goods, &c. Among the archives of some of the ancient Cornish boroughs may be found many mediæval documents of considerable interest and historic value.

There is another class of records, of vast importance as regards the devolution of lands and manors, and the descent of families, which I have omitted to notice. I allude to Charters, Deeds, Manor rolls, and other classes of records connected with matters territorial: I do not know what repositories there may be of such archives in the county of Cornwall, nor do I know if any agent of the Historical Commission has visited and reported upon private collections in the county. But I chance to know that there is a large and very valuable collection of ancient Charters at Tregothnan, and doubtless in other similar houses in the county, to which a gentleman writing a history of the county on a large scale it is hoped would not be refused access, for in such houses much valuable material, unknown to the owners, might be found by an expert. Manor rolls, also, are most invaluable as aids to a local knowledge of the social and economical condition of the rural population in mediæval times. They throw great light on the tenure of land, the customs of manors, which were very various, the systems of agriculture practised, and the gradual abolition of servile tenures. By the enfranchisement of copy-holds, manors are rapidly becoming extinguished, for without copy-holders to form the "homage" the memorial system cannot be carried out.

The great and valuable works of the late Dr. Oliver are doubtless familiar to most persons here, but perhaps some may

not be so well acquainted with his letters under the pseudonyms of "Curiosis" and "Historicus," addressed, from time to time, some years ago, to the "Exeter Flying Post," some of which were afterwards collected and published in three thin 8vo volumes under the title of "Ecclesiastical Antiquities of Devon, and some Memoranda of the History of Cornwall." There is, however, not much in these volumes relating to Cornwall, and the work has become very scarce. Dr. Oliver's papers after his his death passed to Colonel Harding, then of Exeter, afterwards of Upcott near Barnstaple, who, jointly with Mr. Gould, of the Probate Court at Exeter, issued a prospectus for publishing a new and enlarged edition of the Antiquities of Devon in two vols. 8vo. This new work was commenced, and 208 pages were worked off, when the issue ceased, for what reason I have not heard satisfactorily explained.

Colonel Harding, on his death at Upcott in 1886, aged 93, bequeathed the whole of this valuable collection and a vast number of MS. drawings, and other documents, &c., of great interest and value, many of them collected by himself with a view to a new "History of Cornwall and its Churches," which, at one time, he contemplated, to the "North Devon Athenæum and Barnstaple Free Library." It is only natural to expect that these newspaper letters would fall into many hands, and would be preserved by gentlemen of antiquarian tastes. The late Mr. Robert Dymond, of Exeter, had a good many, which are now in the possession of his family. Mr. James Dallas, (one of the Editors of that useful little monthly periodical, published by Pollard, of Exeter, called "Notes and Gleanings,") has many, which are being printed from time to time in that publication. Doubtless, not only the Harding-Oliver collection, but other dispersed slips would be accessible to any antiquary engaged in compiling a new History of Cornwall.

In conclusion, I must say a few words with respect to the great Repository of Historical evidence, The Record Office, in Fetter Lane (London). It is too vast, and its contents too manifold, to admit of my attempting any description of them. I could scarcely touch the fringe of the subject. Here is collected the chief of the treasures which England possesses as the

vouchers of her great history—A collection which, notwithstanding our culpable losses, no nation in Europe can equal. For the purposes of local history, genealogy, &c., important evidence may be found in every class of its documents. But, as regards devolution of manors and lands, and the descent of families, I may mention as the most generally useful the "Plea Rolls of the various courts; The Testa de Nevil; Kirby's Quest; The Returns of Aids and Subsidies; The Inquisitions post Mortem; the Patent, Close and Fine Rolls; The Feet of Fines, Proceedings in Chancery, &c. But I may observe there is no royal road. One document leads to another, and as a student gains experience the more will he become interested in his work, and the greater the pleasure he will take in it.

I had almost forgotten to mention one other depository in which is a vast accumulation of papers of greater or less value, with which literary men generally are not very well acquainted. I allude to the vaults and garrets of the House of Lords. These documents are very various in character. Amongst them is a large number of Private Acts of Parliament authorising various objects—diverting roads and constructing new ones, enclosing commons—the partition of estates among coheirs—dissolving marriages, peerage claims, and other historical materials too numerous to mention, but invaluable to the general and local historian and genealogist. I am glad to be able to add that the Historical Commission is getting these documents calendared as fast as possible, two or three volumes have been already issued, and what is more they are well indexed.

Since writing the above I have received Part I of Vol. XI of the Journal of the Institution, and am very glad to see that the Institution is in a very flourishing condition, both in respect of increase of numbers and literary matter. There are some excellent papers. It would perhaps be invidious to mention names, though it would seem unfair to pass by that of Mr. J. H. Collins, F.G.S., *On the origin and development of ore deposits in the West of England.* This paper is continued from the last volume, and is announced to be further continued. It is a very interesting and valuable paper, though I fear it will be found somewhat over the heads of ordinary lay members of the Institute. As

regards historical and typographical matters, the Journal is not so rich as I should like to see it.

Now ladies and gentlemen, if you agree with me in thinking that a new, enlarged, and authentic "History of Cornwall" commensurate with the importance of the county be desirable, let us consider what practical steps can be taken towards the attainment of that object. You know it cannot be done at once, for there is much preliminary labour to be undergone, and being conscious of this it will be of no use to sit down and contemplate the difficulties. It may be difficult, probably it will, but my maxim has always been that difficulties are made to be overcome. The more you contemplate difficulties the bigger they grow. "Put the shoulder to the wheel." Resolution and perseverance will overcome all difficulties. But we must take a first step. We must make a beginning. If I may venture, as your President to offer a suggestion, I would say form a "Record Society" to collect and print historical materials of record relating to the County. In offering this suggestion I do not intend that a single shilling should be withdrawn from the invested capital of the Institution. A separate subscription should be entered into for this purpose. This has been done, with success, in Somersetshire and in other counties, and I am glad to say that a preliminary step has been taken, within the present month, in the county in which I now reside (Gloucestershire), and I am glad to hear that a suggestion has already been made in Cornwall in the same direction. Good! Let us be courageous and follow it up. Let us, remembering the old Cornish motto: *One and All*, which has done so much for the County, come to a resolution here, and now, to do so. I shall be pleased myself to become a subscriber to such a scheme.

Royal Institution of Cornwall.

ANNUAL GENERAL MEETING.

The Annual meeting was held on November 29th, at the rooms of the Institution, when the chair was taken by the Rev. Canon A. P. Moor, V.P., in the absence of the President, Sir John Maclean. Major Parkyn, Hon. Sec., read the report of the Council as follows:—

"The Council can look back upon a year of great prosperity. There has been a steady advance in the arrangements of the museum, which has been enriched by many interesting gifts, some from the most distant parts. The library also has had many valuable additions, and on its shelves are important works for the student and scholar. The Council are pleased to find that the number of subscribers shews no signs of falling off, and the numerical losses have been more than compensated by the accession of new members. Still, in order to carry out further desirable changes in the arrangement of the museum, the subscribers are asked to use their influence to induce their friends to join. Happily, our obituary notices are on this occasion few. We have had to record the death of the Lord Bishop of Frederickton, better known to Truro people as Bishop Medley, a former incumbent of St. John's in this city, whose connection with the Institution embraces a period of 50 years, during the whole of which he was a diligent reader of the journal of this society. In Mr. T. A. Cragoe, the society has lost one who for many years took a great interest in its work, and in many of our journals will be found contributions of value, especially those illustrating local scenery and horticulture.

We cannot close these notices without referring to the recent death of Miss Curgenven, of Falmouth, who, though not actually a member, yet as the representative of the late Mr. H. M. Jeffery, F.R.S., was continually shewing her interest in the

welfare of the society. The very valuable collection of books, including the publications of the Royal Society, the Mathematical Society, and other costly works, were presented by her from the late Mr. Jeffery's library. She has further shewn her interest in this association by a legacy of £50, the knowledge of which has been communicated to us by her solicitor, Mr. Nalder.

The interest in the museum is well sustained, the number of visitors to all departments shewing an increase during the past year over previous years:—

Admitted free	3955
By ticket	247
By payment	356
Total number ..	4,558

Considerable progress has been made in structural improvements in the rooms of the institution. In the library two large bookcases have been provided for the reception of the many new books received. In each room of the museum two upright cases have been erected to receive specimens. Another structural improvement of considerable cost has been made on the spacious roof of the Institution; two of the gutters have been entirely relaid with lead.

The chief attention of the Curator this year has been given to the classification of the mollusca, and the blending together of the various magnificent gifts of shells from the late Admiral Tucker, Trematon Castle, Mrs. Sharp, Kensington, and Mr. R. Baron Rogers, of Falmouth. These occupy seventeen half cases in the zoological room. Each species is mounted on a millboard tablet labelled with its name and that of the donor, pink tablets being used for Cornish specimens, and white for those from beyond the county. The collection is arranged under two headings made according to Woodward's Mollusca, the other, excluding all foreign molluscs, deals with British shells only. An attempt has been made in the British collection to represent every possible British type by a Cornish specimen if possible. The substitution of sloping shelves in the place of flat ones in the upright cases in the geological and mineralogical room in the museum has effected a great improvement in the display of the objects therein. On walking through the various rooms of

the museum one is struck with their greatly improved appearance, and also with the cases, and the objects in them, added since the last annual meeting. The whole of this reflects the greatest credit upon the Curator, Mr. H. Crowther, who notwithstanding the teaching of the many classes which has necessarily occupied a great deal of his time, shews that one of the chief interests of the Society has not been neglected, and that much care and many long hours of labour have been devoted to this work.

It was very gratifying to the Council to find that on a recent visit to the museum, the Earl of Mount Edgcumbe, a former valued president, expressed his pleasure at the great improvement in all the arrangements. The weather letters have been continued, and contributed to the newspapers, and have aroused the same keen interest as before. It is noticeable that most of the comments in response to those letters are sent on natural phenomena connected with animal life. The letters received on the disappearance of the swallow and martin and the distribution of the clouded yellow butterfly *colias edusa*—have been numerous and interesting. The usual observations have been sent to the Registrar-General, and replies and help given to many correspondents. The minimum wet and dry bulb thermometers, used for many years in the weather screen on the roof of the Institution, which were mounted on brass, have been replaced by the highest class instruments made by Negretti and Zambra, with corrections made at Kew Observatory.

The journal of the Institution was issued in May. It was full of most interesting matter relating to the archæology, mediæval history, and mineralogy of the county, and bears favourable comparison with many of the issues of former years.

The Annual Excursion took place in August, when Dolcoath Mine and Tehidy were the chief places visited. On the mine all the various operations of tin dressing were explained by Captain Josiah Thomas to a large company of ladies and gentlemen, for whom he had also kindly provided a most excellent luncheon. On the party leaving Dolcoath, cheers were given for the worthy manager and Mrs. Thomas for the hospitable manner in which they had entertained their guests. Owing to the heavy showers, the full programme of the day could not be carried out. Tehidy

was the next place visited, where Mrs. Basset and her son, Mr. Arthur Francis Basset, most cordially received the company. A sumptuous tea was served in the handsome dining hall, and after this the artistic beauties were viewed. Notwithstanding the inclemency of the weather, the excursion was one of the most enjoyable the Institution has ever had, due largely to the courtesy and hospitality of Captain and Mrs. Josiah Thomas, Mrs. Basset and her son.

The disused Theatre, formerly used for lectures in the Institution, has been placed at the disposal of the County Council; a Chemical Laboratory has been erected in it, partly at the cost of the County Council, partly from grants earned in the Science Classes in the rooms last winter, a substantial donation of ten guineas from an old friend of the Institution, and other local help. Accommodation is provided for 24 students to work in at one time, and all the available spaces were applied for before the Laboratory was opened. The formal opening of the Laboratory was made by Major Parkyn on October 31st, and short addresses were delivered to the students by Messrs. J. Thomas, C. Barrett, and Hamilton James, on the practical advantages of the study of chemistry. Classes were held last winter, but were not so well attended as might be desired; 19 certificates under the Science and Art Department were earned, for which Government grants were made. The grants and fees amounted to £28 7s. 6d. Classes are again being held under the County Council, Mr. Crowther being the teacher.

The President (Sir John Maclean) having been elected for two years, has still one year to serve. The following are nominated as Vice-Presidents:—the Rev. Canon A. P. Moor, the Ven. Archdeacon Cornish, Dr. Jago, F.R.S., Rev. W. Iago, Mr. John Tremayne, and Mr. Edwin Dunkin, F.R.S. Other members of the Council—Messrs. J. D. Enys, F.G.S., Howard Fox, F.G.S., Hamilton James, F. W. Michell, C.E., Chancellor Paul, Thurstan C. Peter, R. Tweedy, and Revs. A. R. Tomlinson, and A. H. Malan; Mr. A.P. Nix, treasurer, Mr. H. Michell Whitley, F.G.S., and Major Parkyn, F.G.S., hon secretaries.

Since the last annual meeting efforts have been made to draw the various scientific and literary societies in the county more closely together, and a meeting for this purpose was held

on September 30th, when it was resolved that another should take place after the holding of the annual gatherings of the societies interested in the federation. Such a meeting is fixed for Friday, December 2nd, when the whole question will be reviewed, and it is hoped that some satisfactory arrangement will be arrived at. The Council regret the absence of the Rev. W. Iago from its annual meeting, and deeply sympathise with him in the cause of that absence. They always look forward to some paper on local objects, or history of the antiquities of the county from his versatile mind (and are never disappointed). Mr. Iago is now one of the oldest members of the society, and one of the most prolific contributors of papers to its journal."

It was resolved that the report be received, adopted and printed.

The following papers were read:—

"Roads and Road Making," Rev. C. F. Rogers.

"The Rapid Traverser,"—Capt. Henderson.

"The Diamond Prospecting Core Drill,"—S. Rogers, F.G.S.

The Rev. A. R. Tomlinson, rector of St. Michael Penkivel, produced the old register of his parish. It was in a good state of preservation, and the writing remarkably clear. The first entry bears date in the thirty-eighth year of King Henry VIII, three years after his order for the keeping of parochial registers. Mr. Tomlinson also exhibited a curious silver paten used in Lamorran church. The Truro district is very rich in Elizabethan associations, particularly in the form of church plate, and the paten in question bears the date 1579.

The following list of presents to the museum and library was announced.

PRESENTS TO THE MUSEUM.

A large quantity of Physical and Electrical Apparatus, including Cylindrical Electric Machines, Leyden Jars, Electroscopes, Luminous Globes, Discharging Rods, Insulating Stands, Electric Cannon, Chimes, &c.	Mrs. Hyde, Ruanlanyhorne.
Air Pump and Globes, Orrery, and other Pneumatic Instruments	
Skull of a Tiger	

An exceedingly fine specimen of a Peacock, *Pavo cristatus*	Rev. Canon Moor, St. Clements.
A set of Fossils, Coals, &c., illustrating a Coal-seam formation; Baggs, Top-softs, Clay-seam, Best Hards, Bottom Softs. and Iron Stone from Barnsley Bed	H. G. Townsend, Wombwell.
House Coal and Ferns, from Meltom Field Seam, Darfield Main Colliery, Barnsley, Wakefield ..	H. G. Townsend, Wombwell.
Fish Remains, Lepidodendian, Calamites, Anthracosia, Encrinital, Limestones, &c., from Yorkshire Coalfield and Derbyshire Limestone ...	H. G. Townsend, Wombwell.
Specimen in spirit of Alligator, *Nereis*, *Barnacles*,	Rev. A. M. Cazalet, Truro.
A very fine selection of Copper Ores from the Burra Burra Mine, Australia, including native copper, Cuprite, Chessylite, Malachite, specimens of Sanidine and Nepheline rock from Dunedin, New Zealand	John D. Enys, F.G.S. Enys.
Flints from the Isles of Scilly	John D. Enys, F.G.S. Enys.
A large Monocular Microscope, with mechanical stage, eye-piece, one-inch and quarter-inch objectives, spot lense, diaphragm, polariscope, bull's-eye condenser on stand, frog-plate, live box, and stage forceps	John D. Enys, F.G.S. Enys.
Specimens of Orthoclase from the summit of Corcovada Mountain, Rio de Janeiro	John D. Enys, F.G.S. Enys.
Some Bones of the foot of the Moa (Dinornis crassus) an extinct gigantic bird, once common in New Zealand	John D. Enys, F.G.S. Enys.
Collection of Stone Implements, from Chatham Island and a sample from New Zealand	John D. Enys, F.G.S. Enys.
Specimen of the Sheep Plant	John D. Enys, F.G.S. Enys.
Specimen of Black Coral, from the Sandwich Islands	John D. Enys, F.G.S. Enys.
War Clubs from Fiji, & a Boomerang from Australia.	John D. Enys, F.G.S. Enys.
Cast of the Foot-print of a Moa, found in North Island, New Zealand	John D. Enys, F.G.S. Enys.
Specimen of Iridescent Galena from the Isle of Man	John D. Enys, F.G.S. Enys.
Pliocene Shells from St. Erth	Rev. S. Rundle.
Specimens of Tin-stone from Dolcoath, and a Fine Crystalline mass of quartz from Dolcoath ...	Capt. W. Provis, Camborne.
Bronze Tokens	J. Knuckey, Truro.

Quern, from Trevornick, Cubert	F. O. Whitaker, Truro.
Oyster Shells, one on Pipe-bowl, from Truro River	Mark Ball, Truro.
Large Centipede, from Trincomalee, Ceylon ...	A. Coode, Truro.
Spirit specimens of Lizards, Fish, Chameleons, and Skeleton of Head of Dolphin	Miss Holland, Truro.
Horned Toad, from Texas	S. Crowle, Devoran.
Token of Exeter Wooden Mill	Thos. Worth, Truro.
Radiolarian Chert, from Mullion	Howard Fox, F.G.S.
8 Roman Coins (3rd Brass), found about 50 years ago near Lanhydrock, Cornwall...	Rev. F. A. Allen, Meadow House, Fareham, Hants.
Specimens of the rarer British land and fresh-water Shells	Henry Crowther, F.R.M.S.
Copper Ore from New Red Sandstone, Alderley Edge, Cheshire	Henry Crowther, F.R.M.S.
Cast of *Pterodactylus crassirostris*, a flying Reptile of the Oolitic period	Henry Crowther, F.R.M.S.
Cast of Trilobites, including homolonotus, delphinocepahalus, Dudley	G. M. Campbell, Wakefield.
Paradoxides Boltoni, New York	G. M. Campbell, Wakefield.
Isotelus gigas, Ohio	G. M. Campbell, Wakefield.
Tooth of Ctenodus, United States	G. M. Campbell, Wakefield.
Collection of British Birds' Eggs	A. P. Nix.
Collection of Roman Coins	J. C. Daubuz.
Ancient Cannon found in Padstow Harbour	C.G.Prideaux-Brune
Scrolls of the Law formerly used in the Jews' Synagogue, Falmouth	S. Jacob, London.
Specimens of Cinnabar, Sulphide of Mercury, from the Guadaloupe Mines, California	Luke Aver, Chacewater.
Specimens of Cores, or Mineral Samples...	Stephen Rogers, F.G.S.

GIFTS TO THE LIBRARY.

A Legacy of £50 free of duty	Miss Curgenven, Falmouth.
Report of Mines in North Wales, and the Isle of Man	Dr. Le Neve Foster, F.R.S.
An Appeal to the Canadian Institute on the Justification of Parliament	Sandford Fleming, C.M.G.

Notes relating to the family surnames Randall, Rendell, and Rundall	W. W. Rundell, Dulwich.
The Lost Laremic Beds of Middle Park, Colorado	Wailman Cross.
On the presence of Magnetite in certain Minerals and Rocks, and on Iron Rust possessing Magnetic properties	Prof. Leversidge, F.R.S., Sydney.
Notes on some Bismuth Minerals, Molybolanite, and Enhydros	Prof. Leversidge, F.R.S., Sydney.
Indices to the Aeneidea, by James Henry	Miss Emily Malone, Glasmevin.
Seven Centuries of Tin Production in the West of England	J. H. Collins, F.G.S.
The Succession of the Plymouth Devonian Strata ..	R. N. Worth, F.G S. Plymouth.
Fourteenth Report of the Barrow Committee ...	R. N. Worth, F.G S. Plymouth.
Notes on Roman Devon	R. N. Worth, F.G S. Plymouth.
Materials for a Census of Devonian Granites, and Felspars	R. N. Worth, F.G S. Plymouth.
The Batten Skull in the Plymouth Museum... ...	R. N. Worth, F.G S. Plymouth.
Suggested Identification of the Domesday Manors of Devon	R. N. Worth, F.G S. Plymouth.
Technical Education from a Polytechnic Standpoint	R. N. Worth, F.G S. Plymouth.
The Stone Rows of Dartmoor	R. N. Worth, F.G S. Plymouth.
Episcopal Registers, Diocese of Exeter, A.D. 1307 to 1326	Rev. Prebendary F. Hingeston-Randolph
Memorials of Lostwithiel and Restormel	Miss Hext, Lostwithiel.
Victorian Year Books, 1880—1890, ten vols.	Agent General for Victoria, London.
Portrait of the late Henry M. Jeffery, F.R.S.... ...	Miss Curgenven, Falmouth.
Transactions of the Royal Society	Miss Curgenven, Falmouth.
Proceedings of the Royal Society	Miss Curgenven, Falmouth.
Proceedings of the London Mathematical Society	Miss Curgenven, Falmouth.
Penny Cyclopædia, and other Volumes	Miss Curgenven, Falmouth.
Picture of Glasney College	John Burton, Falmouth.
On the Modification of Organisms	David Lyme.
Portrait of Mr. John Tremayne (Past President) ...	In response to request.

British Association Report, 1891 & 1892	J. D. Enys, F.G.S., Enys.
Portrait of Mr. J. S. Enys, F.G.S.	
North American Birds by Capt. Bendire, U.S. Army	
Report of the Mississipi River	
Geology of Iowa, Vols. 1 & 2	
Survey of Wisconsin, Iowa, and Minnesota, U.S.	
Astronomical Expedition, Vol. 2	
Commerce and Navigation U.S., 1854 & 1855 ...	
Mineral Resources of the U.S., 1868	
United States Commission of Fish & Fisheries, 30 Vols.	J. C. Williams, M.P.
The Mathematical Library, comprising some 200 Vols. of valuable and costly works, of the late H. M. Jeffery, F.R.S.	George Pooley, Falmouth.

Dr. Mr. J. P. Dix, Hon. Treas., in account with the Royal Institution of Cornwall. Cr.

Date	Dr.	£	s.	d.
1891. July 31st.	To Balance	0	16	0
1892. July 31st.	„ Interest on Deposit Notes	30	9	0
	„ H.R.H. Prince of Wales	20	0	0
	„ Subscriptions	152	17	0
	„ Visitors' Fees	10	0	0
	„ Sale of Journals	15	13	1
	„ Excursion	19	19	6
		£249	14	7

Date	Cr.	£	s.	d.
1892. July 31st.	By Curator	60	0	0
	„ Fire Insurance	2	14	0
	„ Taxes	1	10	0
	„ Printing : Journal, &c.	65	7	4
	„ Fuel and Gas	10	2	3
	„ Repairs to Building	31	16	7
	„ Museum Expenses	21	19	10
	„ Palæontographical Society	1	1	0
	„ Ray Society	1	1	0
	„ Sundries	14	12	2
	„ Excursion	13	15	8
	Balance	25	14	9
		£249	14	7

TABLE No. 1.

Summary of Meteorological Observations at Truro, in Lat. 50° 17′ *N., Long.* 5° 4 *W., for the year* 1892, *from Registers kept at the Royal Institution of Cornwall.*

1892.	MONTHLY MEANS OF THE BAROMETER. Cistern 43 feet above mean sea level.																		
Month.	Mean pressure corrected to 32 deg. Fahr. at sea level. 9 a.m.	3 p.m.	9 p.m.	Mean of monthly means.	Mean correction for diurnal range.	True mean of monthly means.	Mean force of vapour.	Mean pressure of dry air.	Corrected absolute maximum observed.	Day.	Corrected absolute minimum observed.	Day.	Extreme range for the month.	Mean diurnal range.	Greatest range from 9 a.m. to 9 p.m.	Day.	Greatest range in any 24 consecutive hours.	Between which days it occurred.
	ins.	ins.	ins.	ins.	in.	ins.	in.	ins.	ins.		ins.		ins.	in.	in.		in.	
January	29·926	29·923	29·935	29·929	·004	29·925	·202	29·726	30·533	26	29·151	16	1·382	·082	·23	5	·44	5 & 6
February	29·440	29·430	29·437	29·751	·003	29·748	·225	29·211	30·484	11	29·111	18	1·373	·081	·31	17	·38	17 & 18
March ...	30·019	30·029	30·034	30·028	·007	30·021	·186	29·833	30·557	30	29·326	15	1·231	·097	·33	16	·73	15 & 16
April	30·031	30·016	30·018	30·022	·004	30·018	·257	29·766	30·468	23	29·661	13	0·907	·066	·18	12	·36	17 & 18
May	30·016	30·007	30·003	30·009	·003	30·006	·306	29·[illegible]	30·337	12	29·691	26	0·647	·070	·16	17	·26	27 & 28
June	30·021	30·016	30·028	30·021	·001	30·020	·366	29·657	30·356	30	29·689	2	0·667	·060	·19	23	·28	23 & 24
July	30·016	30·008	30·003	30·003	·002	30·001	·412	29·594	30·271	21	29·503	12	0·768	·070	·21	13	·35	11 & 12
August ...	29·899	29·935	29·913	29·873	·004	29·869	·436	29·460	30·220	10	29·439	30	0·781	·062	·19	31	·32	19 & 20
September	30·023	30·008	30·011	30·009	·004	30·005	·376	29·630	30·340	5	29·514	30	0·826	·067	·17	2	·29	3 & 4
October ...	29·744	29·747	29·755	29·748	·006	29·742	·272	29·476	30·340	19	29·320	28	1·020	·080	·22	20	·35	19 & 20
November	29·974	29·978	29·987	29·978	·004	29·974	·306	29·671	30·496	28	29·561	6	0·935	·073	·20	18	·33	5 & 6
December	29·994	30·000	30·003	29·996	·003	29·993	·235	29·761	30·448	17	29·600	11	0·848	·099	·35	5	·52	5 & 6
Means ...	29·925	29·925	30·010	29·947	·004	29·943	·298	29·607	30·404		29·498		0·949	·076	·23		·39	

REMARKS.—The Barometer used is a Standard, made by Barrow, and compared with the Standard Barometer at the Royal Observatory, Greenwich, by Mr. Glashier. The corrections for Index Error +0·008), Capillarity (+0·018), height above sea (43 feet), and temperature, have been applied.

TABLE No. 2.

MONTHLY MEANS OF THE THERMOMETER.

1892. Month.	9 a.m. Dry Bulb.	9 a.m. Wet Bulb.	3 p.m. Dry Bulb.	3 p.m. Wet Bulb.	9 p.m. Dry Bulb.	9 p.m. Wet Bulb.	Mason's Hygrometer. Mean of Dry Bulb.	Mean correction for diurnal range.	True mean of Dry Bulb.	Mean of Wet Bulb.	Mean correction for diurnal range.	Mean temp. of evaporation.	Wet Therm. below dry.	Mean dew point.	Dew point below Dry Therm.	Self Registering. Mean of all the Maxima.	Mean of all the Minima.	Approximate mean temp.	Correction for the month.	Adopted mean temp.	Daily mean range.	Absolute. Maximum.	Day.	Minimum.	Day.	Range.
	°	"	°	°	°	°	°	°	°	°	°	°	°	°	°		°	°	°	°	°					
January	42·6	38·6	45·0	40·9	41·8	38·0	43·1	0·4	42·7	39·2	0·3	38·9	3·8	34·2	8·9	46·1	34·0	40·1	0·1	40·0	12·1	52	30	19	11	33
February	46·5	41·9	49·2	44·3	45·7	41·0	47·1	0·7	46·4	42·4	0·5	41·9	4·5	37·1	10·0	50·4	38·5	44·4	0·1	44·3	11·9	57	27	21	17	36
March ...	44·5	38·6	47·0	41·0	44·0	38·3	45·2	1·0	44·2	39·3	0·6	38·7	5·5	32·8	12·9	47·4	33·5	40·4	0·2	40·2	13·9	58	19	22	14	36
April	53·0	46·1	56·0	49·1	52·4	45·5	53·8	1·6	52·2	46·9	1·3	45·6	6·6	43·3	13·5	59·9	38·2	49·0	0·1	48·9	21·7	72	7	24	15	48
May	58·0	51·0	59·6	52·5	57·0	50·1	58·2	2·3	55·9	51·2	1·4	49·8	6·1	45·0	13·2	63·0	45·0	54·0	0·8	53·2	18·0	75	13	29	8	46
June	61·6	55·2	65·5	57·6	59·8	54·0	62·3	2·9	59·4	55·6	1·7	53·9	5·5	49·9	12·4	67·5	48·9	58·2	0·3	57·9	18·6	78	28	39	18	39
July	66·0	58·6	69·0	61·1	66·0	59·0	67·0	2·1	64·9	59·6	1·2	58·4	5·5	53·6	13·4	70·3	52·0	61·1	0·3	60·8	18·3	80	30	42	23	38
August ...	64·7	59·4	67·6	61·2	64·4	58·8	65·6	2·0	63·6	59·8	1·2	58·6	5·0	55·2	10·4	69·8	53·8	61·7	0·3	61·4	16·0	78	18	39	11	39
September	58·7	54·6	61·2	56·8	56·8	52·5	58·9	1·7	57·2	54·1	0·9	53·2	4·0	50·9	8·0	64·7	49·7	57·2	0·2	57·0	15·0	70	21	30	18	40
October...	51·0	48·0	53·3	48·9	49·4	45·1	51·3	0·8	50·5	46·8	0·6	46·2	4·3	42·1	9·2	55·5	37·8	46·6	0·4	46·2	17·7	61	6	27	19	34
November	49·1	47·1	52·7	50·4	47·9	45·7	49·9	0·6	49·3	47·7	0·5	47·2	2·1	45·3	4·6	55·8	41·1	48·4	0·1	48·3	14·7	60	4	30	20	30
December	43·0	40·8	45·4	42·8	42·0	39·5	43·5	0·2	43·2	41·0	0·3	40·7	2·5	37·9	5·6	48·8	37·6	43·2	0·2	43·0	11·2	59	21	20	28	39
Means ...	53·2	47·7	55·9	50·5	52·3	47·3	53·8	1·4	52·4	48·5	0·9	47·6	4·8	43·6	10·2	53·3	42·5	47·9	0·3	47·6	15·7	66		29		37

The Thermometers are placed on the leaded roof of the Royal Institution in a wooden shed, through which the air passes freely. The Standard Wet and Dry Bulbs are by Negretti and Zambra, and have been corrected by Mr Glaisher.

TABLE No. 3.

1892.	WINDS.																											
	E.			S.E.			S.			S.W.			W.			N.W.			N.			N.E.			AVERAGE FORCE.			
Month.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	9 a.m.	3 p.m.	9 p.m.	Mean.
January	1	3	4	1	1	1	0	1	1	6	6	6	0	3	2	9	4	6	7	8	9	3	3	1	1·3	1·3	1·4	1·3
February	2	1	2	0	0	1	1	1	0	6	7	8	0	1	0	8	7	8	7	8	8	3	3	2	1·6	1·6	1·6	1·6
March ...	9	8	8	7	8	8	2	1	1	2	3	2	0	0	0	0	0	0	6	5	4	3	6	8	1·6	1·6	1·8	1·7
April ...	4	0	0	4	9	9	4	2	2	2	2	0	0	0	5	3	3	1	8	9	9	5	7	4	1·6	1·6	1·5	1·6
May ...	0	1	4	5	6	6	6	6	1	5	4	6	1	2	3	5	3	4	5	8	5	4	1	1	1·4	1·5	1·4	1·4
June	1	1	0	1	1	1	1	1	2	8	8	9	2	6	4	9	6	7	3	0	2	4	5	5	1·5	1·4	1·3	1·4
July	3	1	0	4	3	7	4	4	0	7	7	7	1	3	4	3	3	4	4	7	3	5	3	6	1·8	1·8	1·7	1·8
August ...	1	0	0	0	1	1	1	0	0	14	15	14	0	1	1	3	2	3	3	5	2	8	7	9	1·8	1·8	1·8	1·8
September	0	0	0	0	0	0	1	1	1	17	17	16	2	1	2	5	6	7	0	3	1	5	2	3	1·5	1·4	1·2	1·4
October ...	1	0	1	0	1	1	1	0	0	5	7	5	0	0	2	1	0	0	4	2	4	19	21	18	1·6	1·6	1·6	1·6
November	0	0	0	1	2	0	1	1	3	12	11	12	2	1	0	1	2	2	0	2	1	12	11	12	1·6	1·6	1·6	1·6
December	0	0	0	2	5	4	1	0	0	9	12	11	0	0	1	4	4	5	1	2	0	11	8	10	1·7	1·8	1·8	1·6
Total	22	15	19	25	37	39	23	18	11	93	99	96	8	18	24	51	40	47	48	59	48	82	77	79	19·0	19·0	18·7	18·9
Means ...	18·2			33·2			17·1			96·0			17·0			46·0			51·2			79·1			1·6	1·6	1·5	1·6

The force of the Wind is estimated on a scale from 0 to 6, from *calm* to violent *storm*.

TABLE 4.

1892. Month.	Average Cloudiness. 9 a.m.	3 p.m.	9 p.m.	Mean.	Rainfall. Rainfall in inches. Truro.	No. of days in which rain fell.	Greatest fall in 24 hours, Truro. Depth.	Date.	Mean weight of vapour in a cubic foot of air.	Mean additional weight required for saturation of the air.	Mean humidity of atmosphere.	Mean elastic force of vapour.	Mean weight in grains troy of a cubic foot of air.	Sun. Shine.	Gleam.	Cloud.	Dry.	Wet.	Remarks.
					in.		in.		grs	grs.		in	grs.						
January	5·4	6·1	6·4	6·0	2·27	22	·74	16	2·30	0·7	78	·197	535·6	30	19	13	63	30	Fog, 18, 19, 20, 26. Snow, 4, 5, 7, 8, 9, 10. Hail, 4, 7, 8, 9, 14, 27. Frost, 2, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 25, 26, 27.
February	5·8	6·2	6·8	6·3	4·43	18	·93	18	2·57	1·0	73	·221	531·3	37	11	10	34	24	Snow, 17, 18, 19. Hail, 1, 2, 17, 19, 20, 21. Frost, 16, 17, 18, 19. 29. Lightning, 18. Thunder and Lightning, 19.
March ...	4·4	3·8	4·5	4·2	1·07	9	·53	15	2·13	1·3	59	·183	5·3·7	44	8	10	86	7	Snow, 9, 10, Hail, 9, 10, 14, 28. Frost, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 28, Frost 29, 30, 31. Gale 15.
April	4·1	4·0	4·6	4·2	1·36	11	·46	28	2·86	1·8	59	·250	525·1	41	9	10	80	10	Fog, 18. Hail, 15. 16, 17. Frost, 1, 2, 3, 13, 15, 16, 18, 19, 30. Swallows, 22, Cuckoo, 16.
May	4·9	4·4	5·1	4·8	1·55	10	·54	26	3·44	1·7	65	·299	520·6	49	6	7	84	9	Frost, 1, 7, 8, 9.
June	3·8	3·0	4·3	3·7	1·83	11	·80	1	4·10	1·6	71	·360	517·2	52	6	2	79	11	Remarkable Rain, 1.
July	5·0	4·5	5·6	5·0	1·76	14	·66	15	4·55	2·5	63	·412	511·0	45	13	4	79	14	Thunder and Lightning, 11, 13.
August ...	5·5	4·3	4·4	4·7	4·40	16	1·90	27	4·87	1·8	72	·436	513·1	43	4	15	73	20	Remarkable Rain, 27.
September	6·1	5·1	5·2	5·5	1·90	16	·63	29	4·24	1·3	75	·373	519·2	39	9	12	74	16	Frost, 18.
October...	5·9	6·2	6·4	6·2	5·70	22	·94	26	3·08	1·1	74	·268	526·8	33	6	23	67	26	Hail, 1, 2, 15, 21. Frost, 5, 11, 12, 17, 18, 19, 20, 24, 28, 30. Gale, 26.
November	5·6	5·7	6·0	5·8	3·11	19	·76	18	3·44	0·6	86	·303	527·7	32	10	18	66	24	Fog, 10, 24. Frost, 17, 18, 19, 20.
December	5·6	5·6	6·6	5·9	2·52	19	·37	1	2·66	0·7	78	·228	534·5	21	20	21	65	28	Hail, 4, 5, 6, 7. Frost, 8, 9, 10, 26, 27, 28, 29, 31.
Means ...	5·2	4·9	5·5	5·2	31·90	187	0·77		3·35	1·4	69	·284	524·8	39	10	12	71	18	

Cloudiness is estimated by dividing the sky into ten parts, and noting how many of these are obscured. The rain gauge at Truro is placed on the flat roof of the Royal Institution, at about 40 feet from the ground. Gleam is recorded when the sun's disk is visible through a film of cloud.

NOTE OF FURTHER EXCAVATIONS ON THE SITE OF LAUNCESTON PRIORY.

BY OTHO B. PETER.

Since the discoveries on the site of this Priory, of which a description appeared in the number of the Journal for April, 1892, I have further explored the land. The opportunity thus arose: Mr. Trood, a local merchant, having purchased the portion of the Priory meadow which is on the north of the Railway cutting for the purpose of building stores thereon with railway access by a siding, I, on behalf of the Launceston Scientific and Historical Society, asked his permission to sink some trial pits within his purchase. He kindly consented, and the result so far as we have gone entirely confirms the suggested outline of the Priory Buildings indicated by my conjectural plan published with the earlier paper.

I have uncovered walls at several points. On the first day I struck the base of a trefoil respond-column on my supposed line of the North Arcade. All the remains discovered are of the purest 12th century moulded type of architecture. Enough of the foundations of the walls exist to indicate the princely proportions of the original structure. Instead of columns forming the arcade walls, which walls are 3 ft. 6 ins. thick, I found semi-columns and then a stretch of wall; indicating arched openings at irregular distances. The semi-columns of the first opening were trefoil shaped, those of the second were a flowing combination of mouldings, and those of the third bowtell moulded. Attached to the Arcade wall foundations in the spaces between the semi-columns are delicate shafts of trefoil form, from whose summits the stone groined roofs once sprang. North of the N. Arcade wall I have laid open the foundations of the outer wall of the north aisle and another wall indicating a north Transept. These walls still retain patches of plaster on them, on the sides which were within the building. I have traced the foundations of the north arcade itself up to 200 ft. from east to west, but the wall is almost totally destroyed beyond the third opening. A finely carved arch key-stone was dug out

lying upside down on the foundation of this wall, about half way between the east and west ends. Some pieces of coloured glass still in the groove of a window mullion were unearthed on the north of the arcade, and several moulded stones. I have also opened upon the line of the South Arcade. This appears to have been similarly constructed to the north arcade, with openings in the wall at intervals to the South Aisle, but unfortunately very little of this arcade apparently remains. In the centre of the Nave at its eastern end evidently stood an altar (probably the High Altar) whose base is about 3 ft. 6 ins. above the floor of the Nave. It was approached by tiled steps from the west. I have found tiles *in situ* at two step levels. On the landing in front of the altar is a grave below the floor line, the sides of which grave are formed with upright slabs of slate. There are probably many more graves near it. Numerous fragments of beautifully carved Bere stone have been discovered around the site of the altar. These may have formed a portion of a screen behind it.

The railway contractor has just commenced cutting the railway siding into the field. The navvies have uncovered the foundations of thick walls, and a portion of a tiled floor 5 ft. below the present surface. This find is on the site which I mark on my plan as that of the Cellarers buildings. The tiles were quite plain and 10 ins. square. The ground around this site is stained as if much good old red wine had been wasted. Foundations have also been struck of the return block of buildings on the West of the cloister, which I mark as the Prior's Lodge, &c. The outer wall of this block is 243 feet from the Eastern wall of the Presbytery.

HISTORICAL NOTES ON THE PARISH, MANOR, AND ADVOWSON OF OTTERHAM, CORNWALL.

By SIR JOHN MACLEAN, F.S.A., F.R.S.A., Etc., *President.*

This does not pretend to be an exhaustive history of the Parish of Otterham. When we commenced the collection of materials for the history of the Deanery of Trigg Minor, which has now for some years been before the public, it seemed to be uncertain whether the Parish of Otterham were really in that deanery or in the Deanery of Trigg Major. In the Taxatio Ecclesiastica of 1291, it is entered in the latter, but in the Valor Ecclesiasticus it is taxed under Trigg Minor. At all events it was considered to be in Trigg Major when we wrote, and the memoir is based thereon. In the recent alterations of the limits of the Deaneries in Cornwall it is placed in Trigg Minor.

The Parish of Otterham is situated in the Hundred of Lesnewth, and contains 3,263 acres. It is bounded on the west by the Parishes of Lesnewth and St. Juliet; on the north by Jacobstow; on the east by Warbstow; and on the south by Davidstow, and lies at a considerable elevation. "Cross roads," on Otterham Down, about a mile west of the church, is 758 feet above the sea level.

Industrial Pursuits, Wages, &c.

The geology of the parish differs considerably from that of the parishes contiguous to it. It consists of a sort of schist, and the soil is very stony, barren, and unprofitable, and becomes quickly overgrown with furze. Laborers' wages vary from 12s. a week to 15s. (with or without a cottage and garden, the value of which is estimated at 1s. a week). Occasional labourers receive half-a-crown a day. Laborers are very well off except for the miserable cottages in which they live. Land being very cheap, most of them have a few acres and keep a cow or two. They are industrious, frugal, temperate, and thrifty. It is very usual for them to become small farmers themselves. Most of them have money in the bank. In some cases they have enclosed land worth 2/6 an acre a year, which in a few years they make worth 20/- an acre. There are no paupers.

Population.

The following table will shew the population of the parish and the number of houses therein according to the census returns at the several decennia within the present century.

	1801	1811	1821	1831	1841	1851	1861	1871	1881	1891
Population	141	176	212	227*	234	198	160	156	163	154
Houses: Inhabited	27	27	37	38	42	31	30	25	27	27
Houses: Uninhabited ...	1	—	—	2	2	8	3	—	—	—
Houses: Building	—	—	—	—	—	—	—	—	—	—

Tithes.

The tithes were commuted on the 8th September, 1841, at £174. The total area of the parish consisted of the glebe lands, 68a. 0r. 9p. statute measure. The estimated quantity in statute measure of all the lands in the parish, exclusive of the glebe, is 3124a. 3r. 2p., which are cultivated as follows:

As arable land	2312	1	18
As meadow	75	1	33
As coarse pasture..	680	2	9
As Orchards	6	1	22
As roads and waters	40	0	0
As church and churchyard	1	0	32

Values and Assessments.

Annual value of real property as assessed upon the parish in 1815	1186	0	0
Gross estimated rental in 1866	1204	9	5
Rateable value in 1866	1088	0	0
Gross estimated rental, 1884	1210	4	5
Ratable value in 1884	1093	15	0

* Of the 43 families composing this population, 34 were chiefly employed in agriculture, 5 in trades and handicrafts, and 4 not comprised in these classes.

According to the Poll-tax levied in 1377 (51 Edward III) the population of Otterham at that date was 60 (see *Journal of the Royal Institution of Cornwall*, 1871, p. 37).

Parochial assessment in 1884—

Sanitary rate	7	0	0			
Highway rate	44	0	0			
County rate, Police rate, Poor rate	94	0	0			
				145	0	0
Land tax: Redeemed ..	4	17	6¼			
Land tax: Payable	42	17	1¾			
				47	14	8

Assessed taxes, 1884—

Inhabited house duty assessed upon the annual value	Nil.		
Property and Income tax assessed upon Schedule A	820	10	0
,, ,, ,, B	15	0	0
,, ,, ,, C, D, E	Nil.		

It will be observed that there was very little difference in the value of real property in 1815 and in 1884.

Pre-historic Remains.

There are no pre-historic remains in this parish except a few small circular tumuli which abound on this and the neighbouring hills. They vary from ten to fifteen feet high, and from ten to twenty-five yards in diameter. They all have a small depression in the centre. One in the adjoining parish of Lesnewith was opened some twenty years ago by the late Mr. Cook of the *Saturday Review*. In the centre was discovered a rude cist built of stone, in which was found human remains, but no weapon or ornament of any kind. A large heap of stones covered the cist. There are not now any ancient christian monuments in the parish.

Ancient Roads and Tracks.

The great road leading from Stratton and the north to the south through Camelford, enters this parish from Poundstock at Sandhill Barrow, and traverses it to within a mile of Titchbarrow when it enters the parish of Davidstow. At "Cross Roads," this road is intersected by a road leading from Warbstow Beacon to the road on Tresparret Down leading from Stratton coastwise through Boscastle and Trevalga to Tintagel, always a place of vast importance. There are various other roads and tracks of minor importance which cross the parish in various directions.

TABLE SHEWING THE DEVOLUTION OF THE

William Carbonell =

William Carbonell =

Galpide de Albemarle = Mabill Carbonell

Reginald de Albemarle =

Geoffry Daumarle =

Nicholas Bonville = Hawis, dau. of Thomas Pyne.

Henry Champernon = Johanna Bodrigan

William Daumarle, s. & h. = Matilda

Sir Rich. Hiwis = Alice, d. & h. of Sir Ralph Blanchminster.

Nicholas Bonville = Johanna, d. & h.

William Daumarle, son & h., b. Easter, 1323. = Ellen

Sir Robert Tresillian, C. J. King's Bench, ob. 1388. = Emiline, d. & h. of Sir Rich. Hiwis.

Sir Wm. Bonville, had livery of seizin, 1265, died 14th Feb., 1407-8, Inq. 9 & 10 Hen. IV, No. 1 Exch. Pro. of Will, 24 Mar., 1408-9. = Margaret Daumarle, dau. & heir, and heir of her great grandfather, Geoffry Daumarle, Inq. p. m. 47, Ed. III, No. 66.

John Hawley, of Dartmouth, died 8th May, 1436, Inq. p. m. Hen. vj, No. 25 = Emily, dau. and h. of Sir Robert Tresillian.

A

John Bonville Inq. p.m., 20, Rich. II, No. 11. = Elizabeth, d. and heir of John Fitz Roger.

a

b

Johanna, d. and co-h of Hugh de St John, s. & h. of Thos. Poynings Lord St John of Basing, by Elizabeth, dau. & h. of Martin Ferrers = Thos. Bonville, presented to Otterham, 1454-1463, aged 5 yrs., on his father's death. = Leva Gorges, d. & h., married Sunday next after Invention Holy Cross, 1425, Inq. p. m., 18 Hen. vi, No. 15. = John Wibbery, presented to Otterham, 1422, died Sunday next after the feast of the Purification B.V.M., 1432-3, Inq p. m., 1 Hen. vj, No. 42.

John Bonville, of Shute, d. August, 1494, Inq. p. m., 9 & 10 Hen. vii. = Johanna Wibbery da. & heir, born on the feast of St. Laurance, 1424, Prob. Etat 18, Hen. vi, No. 15.

B

MANOR AND ADVOWSON OF OTTERHAM.

=JOHANNA BLOYOU.

=Margery.

Sir Simon Berkeley=Margery, daughter of Sir Oliver Carminow.

Roger Fleming=Hester Berkeley. dau. & heir.

John Berkeley ob. s.p.

Ivo DE GORGES= 6th in descent from Sir Ralph de Gorges from Normandy.

Robert Fitzwater =Jane Fleming, dau. & heir.

Ellen, d. & h. of Robert Foliot, of Tamerton Foliot.=Sir Ralph de Gorges.=Eleanor de Morville.

From whom the Russels descend.

Sir Thomas= Gorges

Sir William Fitzwater, ob. 21 Rich. II, Inq p.m. Exch. =Joan, daughter of Nicholas Burden.

John Gorges= Elizabeth, d. and co-h. of John de Doddiscombe.

Oliver Wibbery=

Ralph Gorges=Elizabeth.

John Gorges= of Nearlegh.

Gilbert Wibbery= Margaret Fitzwater, h. of her nephew.

Thomas=Margery s. & h. ob. 1393

Nicholas, b. Jan., 1389.

a

b

RICHARD COPLESTON = | A | B

Adam Coplestone =Alice.

John Coplestone=Catherine, dau. and h. of John Graas, of Tingraas.

John Coplestone =Eliz. Hawley, sis. & heir of Nich. Hawley, aged 30 years, on her brother's death, 1442 | Nich. Hawley, died 7th Sept., 1442, Inq. p. m. 21 Hen. vi, No.

John Copleston, of Exeter. | Walter Copleston, of Bowden. = Elizabeth, da. & sole h. of Thos. Stone. | Philip Coplestone, s. & heir, died 16th Oct., 1472, Inq. p. m. 13 Edw. IV, No. =Ann Bonville, da. and heir.

Thomas Copleston, of Bowden in Yanton. =Katherine, d. of Wm. Fowell of Fowelscombe. | Edward purchased Instow and settled there. | Ralph Coplestone, presented to Otterham 1487, aged 17 on his father's death, 66. =Ellen, dau. of Sir John Arundell of Lanherne.

John Copleston =Isabell, da. of Hy. Fortescue of Prateston. | Nicholas of Nash His grandson, John, sold it to Sir W. Pole.—*Pole's Devon, p. 137.* | John Coplestone, ob. 29 Aug. 1550, Inq. p. m. 4, Ed. VI. = Catherine, dau. of Ralph Bridges, gent. living 1549. — c

George. | Richard of Woodland, 3rd son. =Thomasine, da. of Thos. Floyer, of Floyers, Hayes. | Mary, da. of Sir Wm. Courtenay of Powderham, 1st wife s.p. =Christopher Coplestone, of Copleston son & heir of John, ob. 1589. =Jone, d. of Sir Hugh Pawlet, of Henton, S. George, c. Somerset, 2 wife. —d

Christopher. | Mark. | Robert. | Hugh Copleston, son and heir, ob. s.p.

Adam de Bosco=Alice, dau. of David Servington.

Richard, at Wood=Jone, d. Engelina, dau. of Sir Richard Champernon, of Modbury.

John Wood=Alice, daughter and co-heir of Matt. Newland.

Richard Wood=Jane, daughter and co-heir of Oliver Carminow.

William Wood=Emma, dau. and co-heir of William White of Holcombe, Peramdre.

John Wood=Margery, dau. of Oliver Huish.

John Wood=Anne or Agnes da. of Wm. Pollard of Horwood.

John Wood=Thomasin, d. and heir of Wm. Crase, of Launceston.

Richard Wood=Grace, d. of John Bere, of Huntsham.

Alex. Wood, presented to Otterham in 1524=Anne, da. & heir of Barth. St. Leger, 4th son of John of Holcomb, co. Kent.

c — Richard Copleston, of Otterham, presented to Otterham, 1549.=

Isolda, daughter & heir=Richard Wood, of North Tawton, Devon, presented to Otterham, in 1557 and 1558.

d — John Copleston of Copleston, h. to his brother.=Susan, dau. of Lewis Pollard of Kimpton Bishop.

John Wood, 2 son.

Christopher Wood.=......dau. of Sir John Windham, of Orchard.

Amyas Copleston, of Copleston, aged 39, in 1620.=Gertrude, da. of Sir John Chichester, son of Sir Robert Chichester.

John Copleston, Oct. 12th, 1620, of Copleston, son and heir, sold Chagford to Sir John Whidden, Justice of the King's Bench.

The Fee.

It appears that at the time of the Great Domesday Inquest, the Manor of Otterham was one of the numerous (288) Manors in Cornwall which William the Conqueror bestowed upon his half brother Robert, whom he created Earl of Cornwall. It is recorded "The Earl has one mansion (manor) which is called Otterham, which was held by Edwi on the day on which King Edward was alive and dead. In the same is one hide of land and it paid gild for half a hide. There are six ploughs. This is held by Richard of the Earl. There Richard has in demesne one virgate and one plough, and the villans have the rest of the land and three ploughs. There are six villans and four bordars, and six bondmen and five animals and forty sheep. There is pasture a league long and league broad, and the value per annum is 20 shillings, and when the Earl received it it was thirty shillings."*

Lysons† states that the manor appears to have belonged in the reign of Edward III to the Champernouns, and in this he has been followed, without investigation, by all subsequent writers on the county. The statement can only be received as partially accurate for it must be limited to the *Fee* in chief. The manor itself, with the advowson of the church annexed thereto, was held by others in sub-infeudation, as we shall presently see. Moreover, the record upon which Lysons' statement is based carried the possession of the fee up some 60 years higher.

In the 18th year of King Edward I (1289), when an Aid was levied for the marriage of the King's eldest daughter, William de Campo Arnulphi (Champernon) was returned as holding, *inter alia*, one knight's fee in Oterham, and in 20th Edward III (1346), William de Campo Arnulphi paid the aid on the same fee which his grandfather William formerly held on the King's eldest son (the famous Black Prince) being made a knight.‡ We do not know precisely the date of the death of William Champernon the younger, but many circumstances lead to the conclusion that he was already dead in 1346, and had

*Domesday Survey, Exeter.

†Magna Britannia, Vol. III, p. 251.

‡Book of Aids. Excheq., Queen's Remembrancer's Office, Vol. III.

died probably several years previously. He left two daughters coheirs,* Elizabeth and Katherine, both minors in 1354, though they were probably then both married. Elizabeth married William Polglas on 23rd March 1552-3, as her first husband, by whom she had issue two children, Richard, an idiot, and Margaret, who became the wife of John Hearle. Secondly she married John Sergeaux of Colquite, by whom she had no issue. She survived both her husbands. John died 1387-8, and she in 1395. Katherine also was twice married, first, to Sir Walter Woodehouse, secondly, to Ralph Carminow of Boconnoc, but had no issue.

On the 10th February, 1354-5 a mandate was issued† by the Duke of Cornwall to John Dabernoun, his sheriff and steward for Cornwall, to restore the said manors to Elizabeth and Katherine, daughters of William de Champernon on their attaining full age.

This statement is supported by the following petition of Ralph Carmenowe, Chr., and William Carmenowe his brother, addressed to the King in Council (C. 1562, 1563). Writ dated 10th December, 1st Richard II (1377). They complain that whereas William Chambernon was seized of certain manors and tenements in Devon and Cornwall, and had issue two daughters, which William died, after whose death the two daughters entered into the said manors, &c. as the said William's daughters and heirs, and that they made partition betweem them. One daughter was married to the said Ralph and the other to John Siregeux, which John, covetous to have the entire inheritance, sent divers persons to the manor of the said Ralph of Bockonnoc, and there beat and illtreated the said Ralph and his wife, and took and carried away their goods and chattels to the value of £200, and left the said Ralph for dead; then Ralph gave this manor, which had been allotted to his wife, to divers persons for the term of his life at a certain rent, who left their estate to the said William Carminow, who let the same to Ralph for a term of years yet unexpired. Whereupon the said John Sergeaux, being Sheriff of Cornwall,‡ with a great number of persons,

* Hist. Trigg Minor, Vol. 1, p. 554.

† Council Book of the Black Prince, Duchy Office.

‡ We do not trace that he was ever Sheriff of Cornwall.

armed, under the colour of his office, entered into the manors of the said William which he had of the portion of Ralph's wife as above said, and other lands and tenements of Ralph and took goods and chattels of the value of £1,000, and they pray for a remedy.

John Sergeaux died 16th January, 1387-8.* His wife survived him several years. In 1393 she brought a suit against Sir John Rodeney, knight, and Alice, his wife, for the recovery of a certain chest with writings and muniments therein contained.† Sir John died in 1400, and his relict became the second wife of Sir William Bonville, whom she survived many years.

Elizabeth Sergeaux died at the Priory of Halewell, Islington, London, 11th May, 1398,‡ and was there buried.

There would seem to have been much confusion regarding the fee of the manor of Otterham during the 14th century. As early as 1331, the fees of Penrose Burden and Otterham were vested in John de Dinan or Dynham, who died seized in that year, leaving by his wife Margaret, daughter of Guy de Brian, a son of his own name. He was the eldest son of Joceus de Dinan or Dinham, and he had a younger brother named Oliver. On the inquisition taken at Lostwithiel after his death it was found that he died seized of the Manor of Bodardel, and divers other lands and manors, fees and advowsons in Cornwall. Among the knight's fees he held as many in the county as 27½, one of which was the fee in Oterham, which was held of him by Elias Cotel, and the heir or heirs of Hugh Peverel, and it was worth, as in service, 12[d.] per annum, and John de Dynham, his son and heir, was found to be of the age of 14 years and more.§

On the 20th September in the same year, an assignment of dower was made to Margaret, his relict. She received the Manors of Harpfield in Devon, Bocland in Somerset, and Bodardel, with diver's lands and 10 knight's fees in Cornwall, one of which was Oterham.||

* His writ diem Clausit Extremum was dated 10th May, 11 Rich. II (1388).

† De Banco Rolls, 17 Rich. II, Michs. m. 240.

‡ Inq. p.m., 21 Edw. II, No. 135.

§ Inq. p.m. 6 Edw. III, 1st No., No. 59.

|| Escheats, 6 Edw. III, 1st No., No. 82.

Margaret survived until 15 May, 1357, and on the Inquisition taken at Exeter on the 8th June following, it was found that she held on the day of her death the Manor of Hemyock in Devon together with the Hundred, for the term of her life of the heirs of Oliver de Dynham, knight, who were in the king's wardship by reason of one messuage and 12 acres of land in Iryshland, which the said Olyver held of the king in capite. She also held of the same heirs the Manor of Hydon, and also the Manor of Morlegh in Devon. The heirs were the daughters of the said Oliver, viz.: Margaret, aged 9, Ellene, aged 7, and Mabel, aged 6 years. They were the children of Oliver Dynham, the nephew of the aforesaid John, the husband of Margaret. He died 25 Edw. III (1551). She also held a third part of the Manor of Hartland in dower of the inheritance of her son and heir, John Dynham, then aged 30 years.

Margaret de Brian, on her marriage with John de Dynham, appears to have been the relict of Sir Gilbert de Knovill, and had dower in Batesthorn, Lyddeford, of the Manor of Lodeswille, of the inheritance of the heirs of the aforesaid Sir Gilbert, viz.: John Dun, aged 24 years, Thomas Archard, aged 21 years, and Mabel, daughter of William Luscote, aged 6 years. It may be remarked that in this Inquisition, Margaret is described as Margaret Donnedale.* Polo tells us (Devon Collections, p. 302) that in the 24 Edw. I, Sir Gilbert de Knovill, knight, in the 24 Edward I, held Lodeswell of Lady Milisent de Monte Alto (Montalt) by the payment of 40s. yearly rent. The heirs were his grandchildren.

In 29th Edward I, Sir Gilbert founded a chantry in the Church of Bukynton, Devon, for his own soul and the soul of Hawisia, his wife. Inq. ad quod. damnum, No. 134, Idem.

Margaret, the elder daughter and co-heir of Oliver de Dynham by Margaret, daughter of Richard Hydon, married Sir William de Asthorp,† but we do not find that she carried to him the fee of Oterham or any other of the Champernon possessions.

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* Inq. p.m., 31 Edw. III, 1st No., No. 43.

† In 1379, Sir William de Asthorp, knight, and Margaret, his wife, enfeoffed John Copleston and others in the manor and advowson of Sampford Peverell and Allere Peverell, Devon. Escheats 8 Ric. II, No. 105.

Her two younger sisters became Nuns, one at Bocland, and the other at Walton.*

This would seem to exhaust all the heirs of John Sergeaux, and probably the fee of Oterham again reverted to the family of Champernon, for in the 3rd Henry IV, (1402) when the king levied a similar aid, now called a subsidy, for the marriage of Blanche, his eldest daughter, William de Campo Arnulphi was returned as holding, *inter alia,* one knight's fee in Oterham.† In 6th Henry VI, this fee had become much sub-divided as indeed had most other fees. Thomas Bonvyle and Leva his wife held a quarter part, whereon they paid a subsidy of 20$^{d.}$ Thomas Carwytham, Thomas Oterham, William Chambernon, John Mayow,‡ John Walke, Robert Trecarell, Roger Langdon, Richard Dunecombe, Robert Chamberleyne, Stephen Doyngnell, John Pereu, John Boson, William Wilhouse, Thomas Pruwet, and Robert Calwe, held separately between them three parts of the fee, but because no one of them held a quarter part it was not assessed to the subsidy.§

We next find that upon the Inquisition taken after the death of Leva Bonvill, that Oterham was held by her husband and herself of the heirs of Sir William Bonvill, but how he acquired the fee we know not. See post p. 265.

And the Prior of Tywardreath is returned as holding this fee, and that of Penrose Burden, (see post, p. 266), but we know not how these fees were thus acquired by the Prior.

So much for the fee. We must now advert to

The Manor and the Advowson.

The latter has been annexed to the former so far back as history reaches, but being held by sub-infeudation it is difficult to bridge over the chasm between the time of the Domesday

* Banks's Baronage.

†Subsidy Rolls, 3 Henry IV. We have seen that William Champernon was dead long before this date. It was not unusal for the names of tenants being retained on the Exchequer Book long after their death, nevertheless this may have been another William Champernon.

‡John Mayowe of Smallhill is returned in the same document as holding with several others, the third part of a knight's fee in Treworgye in the Hundred of Lesnewth. Treworgye is, we believe, in the parish of St. Gennis.

§Subsidy Rolls.

Survey and the date at which our public records commence. The earliest holder of the manor of which we have any note is described as "Matilda, the Lady of Oterham," but what her estate in it was, whether in fee of her own right or in dower, does not appear, nor is her family name stated. She presented to the benefice in 1278, and was probably the ancestress, perhaps the mother of Robert the son of William who presented Robert de St. Genesio (St. Gennis) in 1309,* (see post, p. 269) and Simon, the son of John de Genesio in 1311. It is, we think, not unlikely from the fact of two clerks of the name of St. Gennis having been presented in succession, that the patron was also of that family.

The Manor of Otterham, however, not long after the date mentioned above, had became vested in the family of Burdon, by whom it was held together with the Manor of Penros-Burdon, in the parish of St. Breward, which had been granted to Robert Burdon by Reginald, Earl of Cornwall, who died in 1175, hence the grant must have been made before that year, and this grant was confirmed to Peter Burdon, son and heir of the said Robert, by King John, on 5th January, 1200-1, for which confirmation the said Peter gave the king 60 marks and a palfrey. The Manor of Otterham, however, is not mentioned in this confirmation, and we conclude the Burdons must have acquired it by marriage, and by marriage it was carried by Johanna, daughter and heir of Nicholas Burdon, to William Tremblethou, alias William Fitz Wauter or Fitz Walter, who died on the 10th May, 1385, seized, *inter alia*, of the two said manors, the former being held of the King in capite by the 8th part of one knight's fee of the Castle of Launceston, and the latter of John Serjeaux by knight's service, and the jurors add that it is of the value per annum of five marks. They also found that the nearest heir of the said Sir William was his son Thomas, then aged 11 years and more, and they add that John Sergeaux had occupied the Manor of Oterham with the custody and marriage of the heir from the time of the death of the said William to

* Robert, son of William, was one of those returned as holding lands or rents in Cornwall of the value of £20 a year or upwards. 24 May, 24 Edw. I (1296), Harl MS., 1192, fo. 50.

the taking of the inquisition, which was on Saturday next after the feast of St. Gregory (12th March) 9th Richard II (1385-6).*

John Sergeaux acquired the fee in chief of this manor by his marriage with Elizabeth, one of the daughters and coheirs of William Champernon.

A further inquisition was taken at Merwen Church (Marham Church) some dozen years later, viz.: on the Monday next before the Feast of the Conversion of St. Paul, 1397-8, more especially with reference to the Manor of Penrose Burdon, which, there being now no Duke of Cornwall, was held of the King in capite. There is not anything in it concerning the Manor of Otterham, but inasmuch as it gives us some information relative to the issue of Sir William Fitz Wauter, it will be well to cite a few passages. The jurors find that the said Sir William died seized of the Manor of Penrose Burden as of right, which upon his death was seized into the hands of the king, who held it for two years, when he, by Letters Patent, granted to one William Corby all the lands of the said Sir William within the County of Cornwall, together with the marriage of Thomas, son and heir of the said Sir William, to receive annually to the use of the said William Corby £20, and to account for the surplus into the Exchequer. And they jurors say further that in the 12th year of the said king, Edward Earl of Devon entered into the said manor and expelled all who claimed right of the king, and occupied the said manor for five years following and received the profits, and that afterwards the said Earl for the following four years received two parts of the profits and no more, because Margery, who was wife of Thomas Fitz Wauter, received the third part as her dower, and the jurors say that the two parts of the said manor of right pertained to the king until the full age of Nicholas, son and heir of Thomas Fitz Wauter, who was then of the age of four years and more, and was under the guardianship of William Drayton, knight, his uncle, by grant of the king †

From this we learn that Thomas, son and heir of Sir William Fitz Wauter, married Margery, sister of Sir William Drayton, and died circa 1392-3, leaving Nicholas his son and heir,

* Inq. p.m. 8 Rich. II, No. 16.

† Inq. p.m., 21 Rich. II, Exch.

an infant, for four years later, we find he was only four years of age. Of this Nicholas we have no further information. He must have died s.p. and Margaret Fitz Wauter, his aunt, who married John Wibbery, became his heir, and John Wibbery, her grandson, as Lord of the Manor, presented to the church of Otterham in 1422. He married Leva, daughter and heir of John Gorges, who married first John Wibbery of Dartmouth, and died on sunday next after the feast of the Purification of the Blessed Virgin Mary (2 Feb.), 1422-3, leaving his wife great with child. She was afterwards, viz.: on the feast of St. Lawrence, 1424, delivered of a daughter named Johanna. Previously to his death, John Wibbery had conveyed the Manors of Northlegh, Oterham, Penros Burden, Cranysworth, Crockmajor, and Portyllegres to certain trustees. Leva, his relict, on monday next after the feast of the Invention of Holy Cross, 1425, married Thomas Bonville, son and heir of John Bonville by Elizabeth, daughter and heir of John Fitz Roger, and by charter dated 37 Henry VI, granted all the said manors to the said Thomas Bonville, and Leva, his wife, to hold jointly for the term of their lives, and after their deaths remainder to Philip Copleston and Ann, his wife, which Ann was the grand daughter of the said Leva, and the heirs of their bodies, and in default of such issue remainder to the right heirs of the aforesaid John Wibbery. The said Thomas Bonville and Leva were thereupon seized of the said manors for the term of their lives, and the said Leva on the 16th December following died, and the said Thomas Bonville survived and held the said manors solely, and the jurors say that the Manor of Oterham with its appurtenances is held of the heirs of Sir William Bonville, knight, and that its value per annum, beyond reprises, is £10, and they say further that the aforesaid Ann, daughter of Johanna Bonville, deceased, late wife of John Bonville, Esq., and daughter of the said Leva is the nearest heir of the said Leva, and is aged 23 years and more.*

As we have seen above, Anne, daughter and heir of John Bonville by his wife Johanna, daughter and heir of John Wibbery, married Philip Copleston of Copleston, and conveyed

* Inq. p.m., 1 Edward IV, No. 24.

to him the Manors of Penrose Burden and Otterham, of which, *inter alia*, he died seized 16 October, 1472, and upon the inquisition taken thereupon Ralph Copleston, his son, was found to be his nearest heir, and to be aged 17 years and more.*

Ralph Copleston presented to the church of Otterham on 20 August, 1487, an intermediate presentation having been made in 1474 by George, Duke of Clarence and Earl of Warwick, during the minority of the said Ralph, to whom probably the wardship of the minor had been granted. Ralph married Ellen, daughter of Sir John Arundell of Lanherne, and being seized, *inter alia*, of the Manors of Penrose Burden and Otterham, he demised the same to Sir William Courtenay and others in trust to the use of himself and his wife for the term of their lives respectively with remainder over to his sons Nicholas, Thomas, Richard, and John the younger in successive tail male. He died on 3rd September, 8 Henry vij (1492), and John Copleston, his son, was found to be his nearest heir and to be of the age of 16 years and more. The jurors found that the manor of Penrose Burden was held by knight's service of the Castle of Launceston, and that the Manor of Oterham was held of the Prior of Tywardreath by fealty, and was worth per annum four marks.†

We have not succeeded in finding the inquisition post mortem of John Copleston, and we do not know the date of his death, but he would appear to have settled the Manor of Otterham upon his younger son Richard, who, as the true patron, presented to the church in 1549, and in the Herald's Visitation of 1564, he is described as of "Otterham." As early as 23 Henry viij (1531), he suffered a fine, *inter alia*, in this and several other Manors to Humphry Collys, Esq., Humphry Keynes, Esq., Humphry Prideaux, Esq., Thomas Gifford of Halsbury, Esq., John Kelly of Kelly, Esq., and John Pers of Launceston for the nominal sum of 500 marks.‡ This was of course for purposes of settlement probably upon the marriage of his daughter and heir Isota or Isolda with Richard Wood, son of Alexander Wood, who, probably as a trustee, presented

* Inq. p.m., 13 Edw. IV, No. 66

† Inq. p.m., 8 Henry, vij., No. 7.

‡ Ped. Fin. 23 Hen. viij., Mich.

to the church in 1524. Richard Wood and Isotta his wife of course under settlements were joint lords of the manor, and as joint patrons of the benefice presented to the church in 1557. In 1568, by fine they quit-claimed the manor with appurtenances to one Francis Whyddon, who by the same fine re-conveyed it to the said Richard and Isotta for the term of their lives, and after their decease, remainder to John Wood and the heirs males of his body, and in default of such issue remainder to the heirs males of the body of the said Richard, and in default remainder to his right heirs.* Two years afterwards the advowson of the church was vested in the aforesaid John Wood, who suffered a fine therein to one John Carswell, gent.,† who thereupon re-granted the same to the said John for the term of one week with remainder after the expiration of that term to the aforesaid Richard and Isotta, his wife, and the heirs males of their bodies for ever, and after their deaths, in default of such issue, remainder to the right heirs of the said Richard. In 1588, Thomas Torway Yeoman presented to the church for that town by reason of a grant of Richard Wood and Isotta his wife.

Richard Wood and Isotta, his wife, died not long afterwards, and John Wood, their son before mentioned, also died s.p., and the manor and Advowson devolved upon Christopher Wood of North Tawton, who granted the next presentation to Walter Harte and Charles Harte, sons of Edward Harte, of the City of Exeter, who presented in 1603. In 1615, John Wood, supposed to have been the son and successor of Christopher, presented to the benefice, and in 1619, Charles Harte, son of Edward aforesaid, again presented for that turn one William Sheeres, and upon his eviction in 1621, John Wood of North Tawton, in his own right, presented one John Braddon, Clerk. In 1626, John Wood, Esq. and Christopher Wood, his son, suffered a fine in the Manor of Otterham to John Saltren, gent., in which it is described as containing twelve messuages, three cottages, one mill, fifteen gardens, two hundred acres of pasture, two acres of wood, four hundred acres of furze and heath, and thirty-nine shillings rent with appurtenances in Otterham and Jacobstow,

* Ped. Fin. 10 Elizabeth, Hil.
† Ped. Fin. 12 Elizabeth, Hil.

and also the advowson of the church of Otterham, for which remise, quitclaim, and warrant the said John Saltren gave the said John and Christopher Wood the sum of £500.

John Braddon held the Rectory fifty-four years, and dying in 1675, the vacancy was filled upon the presentation of John Saltren, as were all subsequent institutions upon the presentation of members of this family down to the year 1737 inclusive, but the next presentation in the following year was made by William Betenson of Grylls, in the parish of Lesnewth, gent., and the following one in 1779 by John Betenson of Tiverton, in the County of Devon, gent. From this it would appear that as early as 1737 the advowson of the church had been alienated from the manor to which it had always pertained, and was at this time held by the Betenson family *in gross*. The manor itself still continued vested in the Saltren family down to 1757,* when John Saltren and Mary, his wife, suffered a fine therein to Richard Welch, Joshua Thomas, and John Teage, in which it is described as containing fifteen messuages, ten tofts, one mill, thirty gardens, two hundred acres of land, one hundred acres of meadow, twenty acres of pasture, five hundred acres of furze and heath, two hundred acres of moor, and an annual rent of 30/-; and also seven-twelvths parts of one messuage, two acres of land, and two acres of furze and heath, and moreover, of common of pasture for all manner of cattle, with app[ces] in Otterham, and divers messuages in that parish and in the parishes of Egloskerry, Alternun, Laneast, Davidstow, and St. Ive, from which it would appear that divers tenements in those parishes, in which the Saltern family had property, had by them been annexed to this manor. This fine remise and quitclaim was made by the said John Saltren and Mary, his wife, to the aforesaid Richard Welch, Joshua Thomas, and John Teage to hold to the use of the said Richard and his heirs for ever, and for this remise and quit-claim, the said Richard Welch and the others gave the same John Saltren and Mary the sum of £700.†

The manor thus vested in Richard Welch still continues in his descendants.

* King's Silver Book, 31 Geo. II, Mich.

† Ped. Fin. 31 Geo. II, Michs.

The Advowson.

A reference to the Table of Institutions will shew that the advowson of the church since it was severed from the manor has passed through the hands of several parties. The right of presentation continued vested in the Betenson family from 1738 to 1779. In 1810, William Chilcott, of Tiverton, gent., presented as true patron. The following institution in 1850 was made upon the presentation of Charles Henry Daw, of Tavistock, gentleman, and the institution upon the last vacancy in 1887 was made upon the presentation of the Rev. H. T. W. Daw, clerk.

Institutions.

1278. September 27. Master Nicholas Leghe,* Deacon, was instituted to the church of Otterham upon the presentation of Matilda, Lady of Otterham.

1309. April 11. Robert de St. Gennis† (Genesio), Sub-deacon, was instituted to the church of Otterham vacant by the resignation of Simon de St. Gennis‡ (Genesio) who resigned in 1309 upon the presentation of Robert, the son of William (Fitz William?)

1311. January 16. Sir Simon, the son of John de St. Gennis,§ Deacon, was instituted to the church of Otterham vacant upon the presentation of Robert the son of William.

1362. April 26. Richard Kerwytha, Clerk,‖ was collated to the church of Otterham vacant and in the collation of the Bishop by lapse of time.

Unknown. John Mayow resigned for Lesnewth, 6th January, 1421.

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* Bp. Bronescomb's Reg., fo. 89.

† Bp. Stapeldon's Reg., fo. 55.

‡ The Institution of Simon de St. Gennis is doubtless recorded in the Register from 1293-1307, which is missing. His name occurs as Rector, 21st Dec., 1308. Robert de St. Gennis, Rector, had dispensation for non residence for a year from Michaelmas, 1309, renewed 10th Sept., 1310 (Reg. 55[6]).

§ Bp. Stapeldon's Reg., fo. 67.

‖ Bp. Grandisson's Reg., fol. 142.

1422. November 10. Richard Walys,* Chaplain, was admitted to the parish church of Otterham, vacant by the resignation of John Mayow, last rector, at the presentation of John Wybbury, Esq.

An Inquisition having been taken the same day as to the vacancy and right of presentation, it was found that the church was vacant by reason of the resignation of Richard Walys, and that Thomas Bonvill was the true patron, and that he was entitled to present for that turn in right of Leva, his wife, who had been previously the wife of John Wybbury, who was the owner of the manor to which the advowson and right of patronage was appendant.

1454. January 14. John Gunne,† Chaplain, was instituted to the church of Otterham, vacant by the resignation of Richard Walys upon the presentation of Thomas Bonville, Esq., for this turn the true patron.

1463. May 25. John Hoper,‡ Chaplain, was instituted to the church of Otterham, vacant by the resignation of John Gune, last rector, upon the presentation of Thomas Bonville, the true patron.

1474. January 20. John Ewen,|| Vicar of the Parish of Colbrook, exchanged his benefice with John Hoper, Rector of the Parish of Otterham.

Unknown. Louis Pollard.

1487. August 20. John Perie,§ Chaplain, instituted to the church of Otterham, upon the presentation of Ralph Copleston, Esq., vacant by the resignation of Louis Pollard, the last rector.

1506. October 5. John Trowte.

1524. March 24. John Trehane,¶ Chaplain, was instituted to the parish church of Otterham, vacant by the resignation of John Trowte, last rector, upon the presentation of Alexander Woode, Esq.

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* Bp. Lacy's Reg., fo. 41.
† Bp. Lacy's Reg., fo. 286.
‡ Bp. Nevill's Reg., fo. 19.
|| Bp. Booth's Reg., fo. 34.
§ Bp. Courtenay or Tor's Reg., fo. 99.
¶ Bp. Vesey's Reg., fo. 24.

1549. June 3. John Stone, Priest,* was instituted to the church of Otterham, vacant by the death of John Trehane, the last rector, upon the presentation of Richard Copleston, the true patron.

1557. April 30. Henry Torway,† Clerk, was instituted to the Rectory of Otterham, vacant by the resignation of the last Rector, upon the presentation of Richard Woode, gent., and Isotte, his wife, the true patrons.

1588. May 8. Robert Torway,‡ Clerk, was instituted to the parish church of Otterham, vacant by the death of Henry Torway, last incumbent, upon the presentation of Thomas Torway, Yeoman, by the grant of Richard Wood and Isolda, his wife, for this turn the true patron.

1603. October 6. Thomas Bettenson, Clerk, B.A.,|| was instituted to the Rectory of Otterham, vacant by the death of Robert Torwaye, upon the presentation of Walter Harte and Charles Harte, sons ot Edward Harte, of the City of Exeter, gent., the true patron by the grant of Christopher Wood of North Tawton, Esq., the original true patron.

1615. October 27. Robert Langeston,§ Clerk, was admitted to the Rectory of Otterham, vacant by the resignation of Thomas Bottyson, last Rector, upon the presentation of John Wood of North Tawton, Esq., the true patron.

1619. January 15. William Sheeres,¶ Clerk, was admitted to the Rectory of Otterham, vacant by the death of the last incumbent upon the presentation of Charles Herte, son of Edward Herte, of the City of Exeter, the true patron.

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* Bp. Veysey's Reg., fo. 132.

† Bp. Turberville's Reg., fo. 19.

‡ Bp. Woolton's Reg., fo. 37.

|| Bp. Cotton's Reg., fol. 78. Thomas Bettenson matriculated as from Exeter College, Oxford, 5th May, 1598. His father is described as "Pleb."

§ Id. fo. 105. Benefice sequestrated on the death of Robert Langeston, 24 Sept., 1619. Act Book A.

¶ Id. fo. 112.

1621. August 11. John Braddon, Clerk, was admitted to the Rectory of Otterham, vacant by the death of Robert Langeston, Clerk, late incumbent of the same,* and by the eviction of William Sheeres last incumbent, upon the presentation of John Wood of North Tawton, the true patron.

1675. May 11. George Wakeham,† Clerk, B.A., was admitted to the Rectory of Otterham, vacant by the death of John Braddon, Clerk, last incumbent, upon the presentation of John Saltren, gent., the true patron.

1681. March 1. Hugh Warren.‡ Clerk, was instituted to the Rectory of Otterham, vacant by the resignation of George Wakeham, last Rector, upon the presentation of John Saltren of Slade, in the parish of St. Ive, Co. Cornwall, the true patron.

1684. August 7. Samuel Northcote,‖ Clerk, was admitted to the Rectory of Otterham, vacant by the death of Hugh Warren, last Rector, upon the presentation of John Saltren, gent., the true patron.

1706. October 3. Thomas Sargeant§ was admitted to the Rectory of Otterham, vacant by the death of Samuel Northcote, last Rector, upon the presentation of William Saltren, Esq., the true patron.

1707. August 1. John Vivian was instituted to the Rectory of Otterham, upon the presentation of William Saltren, Esq.

John Vivian, B.A., was admitted to the Rectory of Otterham 1st August, 1707, by Dr. Tenison, Archbishop of Canterbury, *sede vacante*, (Reg. II, 2383), in the interval between the translation of Bishop Sir Jonathan Trelawny, Bart., to the See of Winchester, 14 June, 1707, and the consecration of Bishop Blackhall, 8 February following. Bp. Blackhall died from a fall from his horse 29th November, 1716, aged 66

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* Bur. at Otterham, 24 Feb., 1674-5.

† Bp's. Reg. New Series, Vol. II, fo. 37.

‡ Id. vol. III, fo. 20.

‖ Id. fo. 47. Samuel Northcott, Clerk, Rector, bur. 24 Aug., 1706.

§ Id. Vol. IV, fo. 149.

1708. July 3. James Avent, B.A.* was instituted to the Rectory of Otterham, vacant by the resignation of John Vivian, upon the presentation of William Saltren, gent.

1724. May 25. William Cruwys, B.A.† was instituted to the Rectory of Otterham, vacant by the death of James Avent, last Rector, upon the presentation of John Saltren of Treludick, Esq.

1737. April 30. Joseph Silly‡ was instituted to the Rectory of Otterham, vacant by the death of William Cruwys, last Rector, upon the presentation of William Saltren, Esq.

1738. September 6. William Snawdon, B.A.,‖ was instituted to the Rectory of Otterham, vacant by the resignation of Joseph Silly,§ last Rector, upon the presentation of William Betenson of Grylls, gent.

1779. August 12. Digory Joce, Clerk, was¶ instituted to the Rectory of Otterham, vacant by the death of William Snawdon, upon the presentation of John Betenson of Tiverton, Devon, gent.

1810. August 10. Samuel Chilcott, B.D.,** was instituted to the Rectory of Otterham, vacant by the death of Digory Jose, last Rector, upon the presentation of William Chilcott of Tiverton, gent., true patron.

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* Id. Vol. V, fo. 5. 1724, James Avent, Clerk, Rector, bur. 9 Mar. 1724.

† Id. Vol. VI, fo. 16.

‡ Id. Vol. VII, fo. 8.

‖ Reg. New Series, Vol. VII, fo. 26.

1741.	Easter, dau. of William Snawdon, Rector, and Mary his wife, bap. 24 May.				
1743.	John, son of	Do.	Do.	Do.	bap. 6 Dec.
1745.	William	Do.	Do.	Do.	bap. 22 ,,
1747.	Elizabeth, dau. of	Do.	Do.	Do.	bap. 21 Feb.

§ He was son of John Silly of Kernick, in the parish of Helland, was instituted to the Rectory of Lanivet, 1738, and was buried there 16 April, 1739. s.p. see. Hist. of Trigg Minor, Vol. II, p. 521.

¶ Id. Vol. IX, fo. 159. Son of John Joce, and Anne his wife, bap. at Lesnewth, 12 April, 1732. Rev. William Snawdon bur. at Otterham, 2 March, 1779.

** Id. Vol. XI, fo. 33.

1850. July 30. Glanville Martin, B.A.,* was instituted to the Rectory of Otterham, vacant by the death of Samuel Chilcott, last Rector, upon the presentation of Charles Henry Daw of Tavistock, Devon, merchant.

1861. September 5. Charles Henry Thomas Wyse Daw, M.A.† was instituted to the Rectory of Otterham, vacant by the resignation of Glanville Martin, last Rector, upon the presentation of Charles Henry Daw of Tavistock, merchant.

1873. March 4. John Gillard, B.A.‡ was instituted to the Rectory of Otterham, vacant by the resignation of Charles Henry Wyse Daw, M.A., last Rector, upon the presentation of the crown for this turn by reason of the lunacy of the true patron.

1875. October 5. Robert Martin Smith, B.A.|| was instituted to the Rectory of Otterham, vacant by the death of John Gillard, last Rector, upon the presentation of the crown as before.

1883. May 29. William Dunstan Rundle, M.A.§ was instituted to the Rectory of Otterham, vacant by the death of Robert Martin Smith, last Rector, upon the presentation of the crown as before.

1887. Edward Henry Archer Shepherd was instituted to the Rectory of Otterham, vacant by the resignation of William Dunstan Rundle, upon the presentation of the Rev. C. H. T. Wyse Daw, Clerk.

The Parish Church.

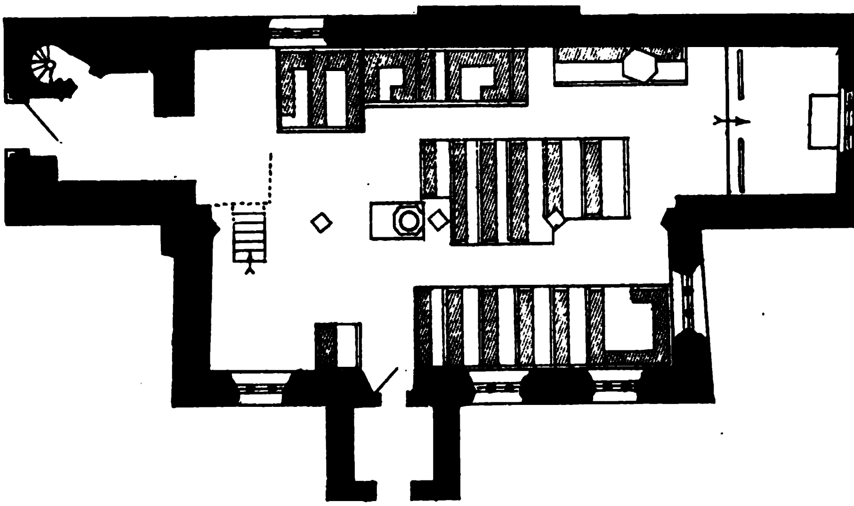
The Parish Church of Otterham is dedicated to St. Denys, and consists of chancel, nave, and south aisle, west tower and south porch. Formerly it had a transept on the north side, but some forty years ago this was removed and the arch walled up. The arcade between the nave and south aisle is of four bays, the

* Id. Vol. XIII, fo. 71.
† Id. fo. 161.
‡ Id. Vol. XIV, fo. 80.
|| Id. fo. 105.
§ Truro Register, Vol. 1, fo. 49.

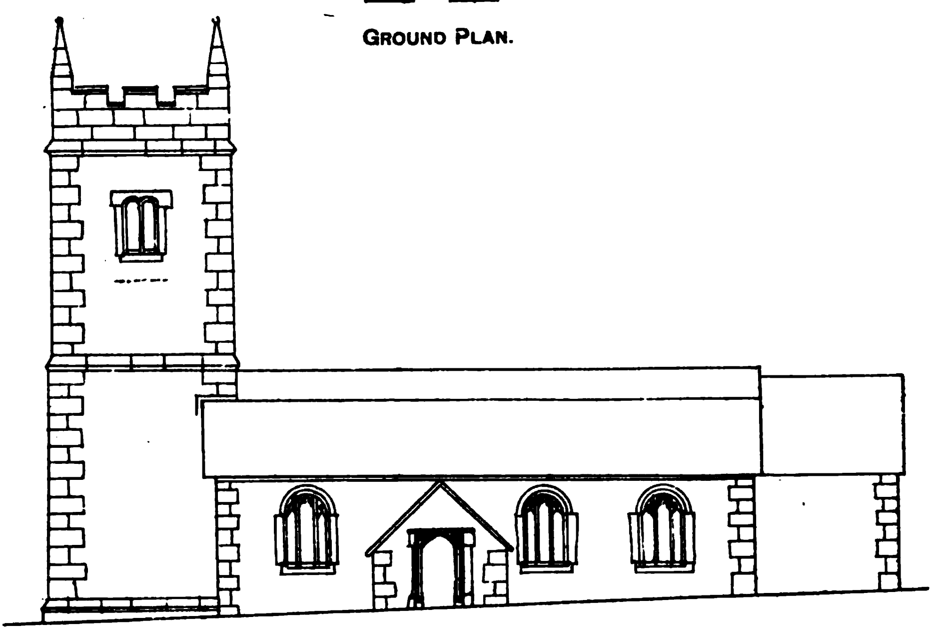
OTTERHAM CHURCH.

ST. DENIS, OTTERHAM.

AS EXISTING IN 1884.



GROUND PLAN.



SOUTH ELEVATION.

SCALE:—16 FEET TO 1 INCH.

arches being supported by monolith granite columns. The tower is of two stages with a crenellated parapet and four small pinacles. The doorway of the south porch is square-headed with four-centered arch, and the western or tower door is the same and of good granite work. The east window in the chancel is of three lights with tracery in the head. There is a somewhat similar window without tracery at the east end of the aisle and three others of a like character in the south wall, and one in the north wall of the nave, all of the same type. The tower was built in 1702, and is about 45 feet in height, the tower arch being round and not centrally placed. In the tower are three bells, all mediæval. The first and third have legends on them, but the second is quite plain. The legends are:

I. ✠ **Voce mea viva de pello cuncta nocina.** Diameter at the mouth, 27½-ins.

II. This bell has no legend. Diameter at the mouth, 29¾ inches.

III. ✠ **Est michi collatum ihc istud nomen amatum.** Diameter at the mouth, 32¾-ins.

Both the legends are in Old English characters.

The interior of the church is in a very dilapidated and bad condition. The old oak seats remain in the church, but they are not carved nor have they ever been, but they appear to have been planed, though they shew some traces of colouring. The tie-beams of the roof and the wall plates are carved, but were very thickly coated with lime-wash, which has been removed by the rector, the Rev. W. Dunstan Rundle. Parts of the base of the screen remain *in situ* and shew traces of colouring. The font is octagonal and of granite.

The only piece of altar plate now remaining is an Elizabethan Communion Cup with a paten cover, of the usual type, and a pewter paten.

THE MONUMENTS IN THE CHURCH, ETC.

There are few monuments, the earliest is of the date 1652. It consists of a ledger stone circumscribed with the following words: Mary y^e wife of Abel French, gent., and daughter of George Hele, of Whitstone, Esq., who departed this life on y^e vj of October, Anno Domini, 1652, æt suæ, 35.

In the centre at the head, is a shield with elaborate mantling, helmet, and wreath, but without a crest. The arms are a bend, or bendlet, between two dolphins naiant. impaling, five lozenges in bend, each charged with an ermine spot (see below).

Underneath the shield are the following lines:

Faith, virtue, patience, love, and all in all,
This Godly Matron had ever at her call,
Whose lyfe, whose death, whose charitie, whose fame,
Lyeth still recorded in the book of fame,
And though this wall doth parte her love and shee
Their souls are coheirs of felicitie.

See here shee lyes who did alwaies walk by ye lyffe of this good wife.

Feare God her neighbour love
And thou shalt live above.

A large stone was found under a seat circumscribed as under:

Here lyeth y^e body of Alice, y^e wife of William Grigg, deceased, who was buried the 24th of January, 1684.

In the middle of the stone the following:

Here Alice Grigg doth intombed lie,
Whose spirit mounteth to the starrye skie,
Unto the poor she had a good regarde,
Which daily cry heaven be thy rewarde.

On a stone affixed to the wall is the following inscription:

In Memory of Johan, the wife of William Moyse, and daughter of Johan Avery of Kernick, gent., who was buried here underneath, March 14th, in y^e year of our Lord 1720-1. *Etatis suæ*, 48.

Then below the burials of:

Henry the son of	William Moyse and	Johanna his wife,	Feb. 9,	in the y^r	1700.
Another Henry	do.	do.	June 18,	do.	1702.
Thomasine, dau.	do.	do.	Mar. 26,	do.	1709.

Behold the husband and the wife,
Three children also here do lie.
Soon young as old depart this life,
Lord make us all prepare to die.

IN THE CHURCHYARD.

Just outside the church and now clamped against the wall is the following:

Abel French, of Smallhill, gent., who departed this mortal life on the fourth day of May, in the year of our Lord God, 1660. Ætatis (?)*

On the middle of the stone is the following:

To truth, to prince, to rich, to poor, to all,
Steadfast, faithfull, kindly, good, and liberal;
Hee always was, and tho his bones here lye,
His works shall prayse him still his fame ne'er dye,
Happy the dead tha' live and happy they
Whome death will not have live, Life not have dye, [sic but query].
Lett my posteryty forbear to take
My bed of rest their sepulchere to make.

* This stone is much mutilated, in fact broken into two pieces, it is gratifying however to know that it has received every care from the Architect, under whose direction the church was rebuilt.

Family History.

So far as we know, the only family of gentry ever permanently resident in the parish, was that of French, which was settled at Smallhill as early as the beginning of the 17th century. Unfortunately the Parish Registers only commence in 1687, and they do not aid us much in the compiling a pedigree of that family. We find, however, that in the 14th of Elizabeth, William ffrench paid the lay subsidy, on goods in Otterham on £9, being the highest lay subsidy in the parish. In the 22 James John ffrench paid on goods £11, Roll $\frac{88}{226}$. John ffrench 22 James $\frac{88}{296}$, and in 17 Charles, William ffrench, gent., paid £2 on lands Id. $\frac{89}{334}$. There are numerous entries of the name. Among them the prevailing christian name is Abel, which renders the descent very confusing without the aid of deeds and wills, which are not at present accessible to us.

Over the principal entrance to the house there is an escutcheon of arms, but it is so thickly covered with lime-wash that the charges cannot be very clearly defined, but see post page 276.

In the early part of the present century, the heiress of the family of French married ...... Chichester, and in 1841, when the tithes were commuted, Robert Chichester, Esq., is stated to be the owner of Smallhill, and it still remains vested in that family.

At the end of the 17th century and beginning of the 18th, another family of some local repute resided at Kernick in this parish. Peter Prest was buried in 1710, and the name continued on the registers until close upon the end of the century.

At the time the foregoing notes were taken, an effort was being made by the Rector to raise funds for the purpose of putting the ancient church into thorough repair for divine worship, for which plans and estimate had been obtained from the well-known architect, Mr. J. P. St. Aubyn, of London, for the purpose of executing the work. To Mr. St. Aubyn's courtesy we are much indebted, as we have been on many former occasions in like circumstances, for the plan and elevation of the then church prepared for this work. At this juncture, however, Mr. Rundle

received preferment in Devonshire, and his connection with Otterham consequently ceased. Mr. Shepherd, however, his successor, entered with great zeal upon the work of rendering the parish church suitable for divine service. This has caused many inevitable changes, but we are informed that the church has been rebuilt upon the old foundations, and that much of the old granite work has been re-used in the new building.

School.

There is no school in the Parish of Otterham. The children, together with those of the Parish of Lesnewth, attend the National School at St. Juliet, and representatives from Otterham and Lesnewth are on the Board of Management, the Rector of St. Juliet being the chairman.

The Parsonage House.

The present parsonage house was built about 40 years ago, during the incumbency of the Rev. Glanvill Martin now (1893), Vicar of Halwell, near Totnes. It is within a few yards of the site of the old parsonage, which was then taken down. It is a well-built and convenient residence, surrounded by trees with a pretty lawn sloping down to a large sheet of water, ornamented by some of the finest beeches in the neighbourhood, and by a pair of swans and other water fowl, and stocked with gold fish and carp. The house is within two minutes walk of the church.

We must not conclude these remarks without tendering our warm thanks to the Rev. W. Dunstan Rundle, the late, and to the Rev. E. H. A. Shepherd, the present, Rector, for much assistance very kindly given in their preparation.

PAPER AND SKETCH MAP OF CORNWALL, SHEWING THE LOCALITY OF VARIOUS ROCKS POSSESSING POWER TO DEFLECT THE MAGNETIC NEEDLE.

By THOMAS CLARK, Truro.

During the past summer I have devoted my spare time to testing and mapping the basic rocks of Cornwall, believing this subject to be worthy the attention of the miner, surveyor, and mariner.

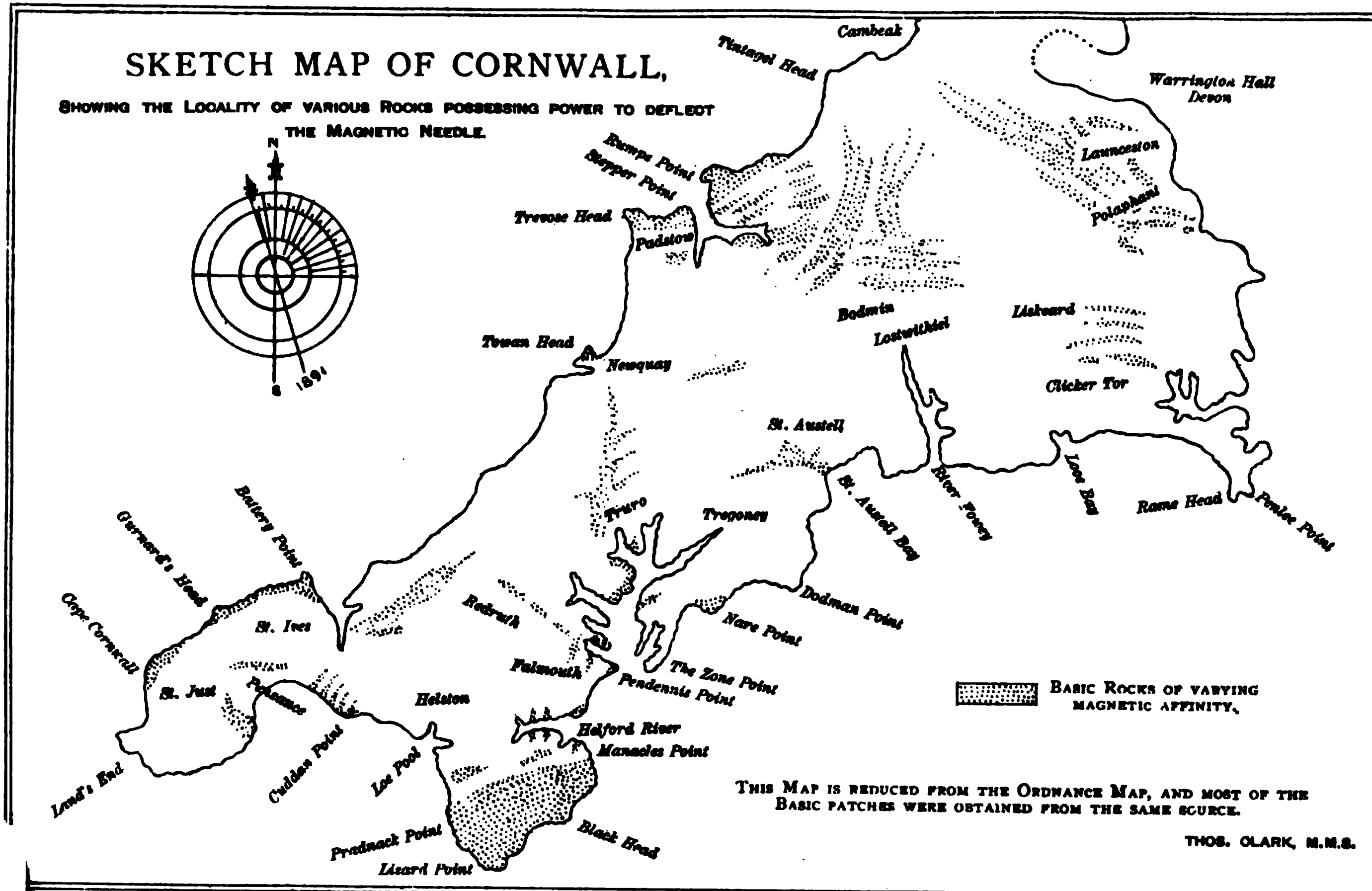
I am not aware that anyone, up to the present time, has ever attempted to ascertain the percentage of affinity or power of such rocks over the bar magnet or needle, by scales and weights.

The short notes I made for a former Journal respecting the magnetic power of the Lizard rocks, has called for a far more extensive research of our coast line, which is about 180 miles in extent, and jutting far out into the great marine highway of nations. This work I commenced in earnest, and obtained materials from almost every available point, not being desirous of pursuing the course of the mistletoe for either matter or shelter, but with a full intent to record faithfully my own work on the subject.

I am indebted to Mr. Howard Fox, of Falmouth, for the sample of Canna basalt, the high power of which I have used as a standard for other rocks. This sample was a portion of the rock known as Compass rock, situated on the apex of the Island of Canna in the Hebrides. It acquired its name from the fact that when a mariner's compass was taken round it, the end of the needle mark N. would point to the rock, whether the observer placed the compass E., W., N., or S., of it. This extreme power of the rock over the needle only extended a short distance, for at 80 yards the needle is recorded to nearly assume its normal position, only deflecting 1 deg. $\frac{6}{10}$; but I have found for this hitherto basic champion of the British Isles, rivals in Cornwall,

SKETCH MAP OF CORNWALL,

SHOWING THE LOCALITY OF VARIOUS ROCKS POSSESSING POWER TO DEFLECT THE MAGNETIC NEEDLE.



THIS MAP IS REDUCED FROM THE ORDNANCE MAP, AND MOST OF THE BASIC PATCHES WERE OBTAINED FROM THE SAME SOURCE.

THOS. CLARK, M.M.S.

both from St. Just in the west, and Polyphant in the east, whose magnetic powers far surpass that of the Canna stone, as will be seen by the following table: —

	Full weight in grains.	Reduced by Magnet.	Affinity for Magnet.	Percentage of Affinity for Magnet.
Botallack	289·7	250·9	38·8	13·4
Polyphant	241·5	218 9	27·6	11·4
Canna	278 8	257·5	21·3	7·6
Catacleus	201·7	216·0	15·7	6·7
Blackhead, Lizard	236·9	222·6	14·3	5·9

I selected from my collection of Cornish rocks 4 samples (from which I cut 4 slices of each) and tested their various affinities, the results of which is appended.

The St. Just sample I obtained from Capt. James Bryant; it is from the celebrated Botallack mine, and was raised from 112 fathoms below the sea. This class of rock passes down obliquely from the lichen-covered ridges of the hillside, far out beneath the sea, and its magnetic power has hitherto baffled all attempts of the engineer to work out his explorations by the aid of the compass only.*

The sample of Polyphant stone was obtained from one of the quarries, near Launceston, about 20 ft. from the surface. The magnetic affinity of the rock has, I believe, been hitherto unknown, the quarries being situated several miles inland, far away from the mariner's course, and in a part where mining operations are very rarely conducted. In connection with this rock, I found that in the shallower parts of the quarry much of the magnetites, through atmospheric influence, were changed into amatite, therefore in many cases it had lost much of its influence on the magnet.

Fresh samples of the Catacleus stone (from the neighbourhood of Padstow) are very difficult to obtain, it being a long time since any of it has been quarried for building purposes (that used for road-metalling is a different material); I was therefore compelled to fall back for my test sample on fragments of the

* A sad catastrophe has recently occurred at Wheal Owles Mine, St. Just, by the tapping, at a great depth, of an old mine adjoining, thereby flooding Wheal Owles and drowning 20 of the miners. I have but little doubt that this sad mishap will some day be traced to the miner having been misled in his explorations by the deflection of the Magnetic Needle.

rock that had been in the walls of Colan church since the year 1336, and it yet retains noteworthy affinity for the magnet, which the humid atmosphere of Cornwall has failed to destroy.

The next sample was obtained from the Blackhead, Lizard. The rocks of this district I very briefly referred to in a former Journal, but since then I have gleaned much fresh information respecting them and the district in general. I find that the Porthallow banded gnëisses and serpentines N. of the Manacles Point are more highly impregnated with magnetic fluid than I had evidence of 12 months since, a condition I find also in the dark serpentines and steatites a little west of the Blackhead; and fresh samples from the Manacles Point have also revealed a higher percentage of power than the former ones.

In preparing my slices of rocks for the magnet, a difficulty presented itself which had not previously occurred to such an extent, viz.: the great rise in the percentage of power caused by the friction of the saw; in some cases it raised to 25 per cent. above its normal strength, and after a repose of a day or two, the power would be found to have considerably relapsed, but would again, after a more extended period, regain their normal strength; this is undoubtedly throwing a new light on the subject. The slices of Polyphant stone were cut off with a tooth-saw, which did not produce such an amount of friction as would occur in a harder stone cut with a toothless saw and emery, therefore I did not test for a rise or fall as in the other samples.

The following table shows the rise and fall in the Magnetic affinity, by friction in sawing, of the St. Just Hypersthene rock.

AFTER 8 HOURS REPOSE.					FRESH CUT AND AFTER 28 DAYS REPOSE.				
	Full weight in grains.	Under the Mag.	Affinity for Mag.	Percentage of affinity.		Full weight in grains.	Under the Mag	Affinity for Mag.	Percentage of affinity.
No. 1	62·7	50·0	12·7	20·2	No. 1	62·6	49·0	13·6	21·7
No. 2	98·6	92·5	6·1	6·3	No. 2	86·3	75·0	11·3	13·0
No. 3	124·5	111·0	13·5	10·8	No. 3	72·3	64·5	7·8	10·7
No. 4	68·5	65·0	3·5	5·1	No. 4	68·5	62·4	6·1	8·9
Totals	354·3	318·5	35·8	10·1	Totals	289·7	250·9	38 6	13·4

After a further repose of 12 months the average affinities were the same.

No. 2 slice, immediately after being sawed, acquired the intense affinity for the magnet of 45·6 per cent. of its weight, and 48 hours later it relapsed to 6·3 per cent.; in 28 days after, being reduced in size, it acquired the power of 13 per cent., which I take to be its normal affinity.

These figures show how much the magnetic powers of such rocks may be intensified by friction; such being the case in a small portion, I consider in the case of miles of basic beach and cliffs, with its thousands of tons of boulders and shingles of the same nature brought into motion by such storms as oftentimes visit our coast, that the magnetic power would be increased to an almost incalculable degree, to which water would be no barrier, for we all know its conducting properties for magnetism. This power it is dangerous to despise, as it may greatly imperil any misguided ship that unfortunately drift within its influence.

From the observations of Messrs. Rüker and Thorp, the influence on the magnet of the Canna basalt cap scarcely reaches down to the sea, but such is not the case with some of the Cornish rocks, for they extend far beneath the sea, viz.: at Botallack, St. Just, and in the Lizard district.

POLYPHANT STONE, NEAR LAUNCESTON, AFTER REPOSE.	Full weight in grains.	Reduced by affinity	Affinity	Percentage of affinity.	CANNA BASALT AFTER REPOSE.	Full weight in grains.	Reduced by affinity.	Affinity	Percentage of affinity.
No. 1	52·2	46·0	6·2	11.8	No. 1	78·3	73·5	4·8	6·1
No. 2	65·1	57·5	7·6	11·6	No. 2	68·9	64·5	4·4	6·5
No. 3	62·3	55·0	7·3	11·7	No. 3	49·5	45·5	4·0	8·0
No. 4	61·9	55·4	6·5	10·4	No. 4	82·1	74·0	8·1	9·8
Totals	241·5	213·9	27·6	11·4	Totals	278·8	257·5	21·3	7.6
CATACLEUS STONE AFTER LONG REPOSE.					BLACK HEAD SERPENTINE, AFTER REPOSE.				
No. 1	21·5	19·5	2·0	9·3	No. 1	57·1	53·2	3·9	7·0
No. 2	70·5	65·1	5·4	7·6	No. 2	52·8	49·5	3·3	6·2
No. 3	70·4	66·8	3·6	5·1	No. 3	53·2	49·9	3·3	6·2
No. 4	69·3	64·6	4 7	6·7	No. 4	73·8	70·0	3·8	5·1
Totals	231·7	216·0	15·7	6·7	Totals.	236·9	222·6	14·3	5·9

The average affinity of each sample of rock after 12 months repose was very similar.

The bar magnet employed was 1 foot long, 1¼ inch wide, and ¼ inch thick.

A slice of rock with an affinity of 5¼ grs., was sufficient to hold this bar magnet at right angles, either east or west of the magnetic poles of the earth.

AN OGAM STONE AT LEWANNICK, CORNWALL.

BY ARTHUR G. LANGDON.

(Reprinted by permission from the Journal of the British Archæological Association. Vol. 48, 1892).

It has always been a matter of some surprise that no monument bearing an Ogam inscription has hitherto been found in Cornwall, as in the adjoining county of Devon two have been discovered: viz., one from Fardel, now in the British Museum; and another from Buckland Monachorum, now at Tavistock.* I am, therefore, extremely glad to be able to report the discovery of such a stone on 7th June last in the churchyard of Lewannick. This place is situated about five miles south-west of Launceston. The stone stands on the south side of the churchyard, near a large tree. No doubt the readers of this *Journal* will recollect that the church was destroyed by fire on 11th January, 1890, and although, since its rebuilding, it has been visited by numbers of people, it is remarkable that no person has observed the characters on this stone. Even the old sexton informed me that he had never heard that it had attracted the notice of any one.

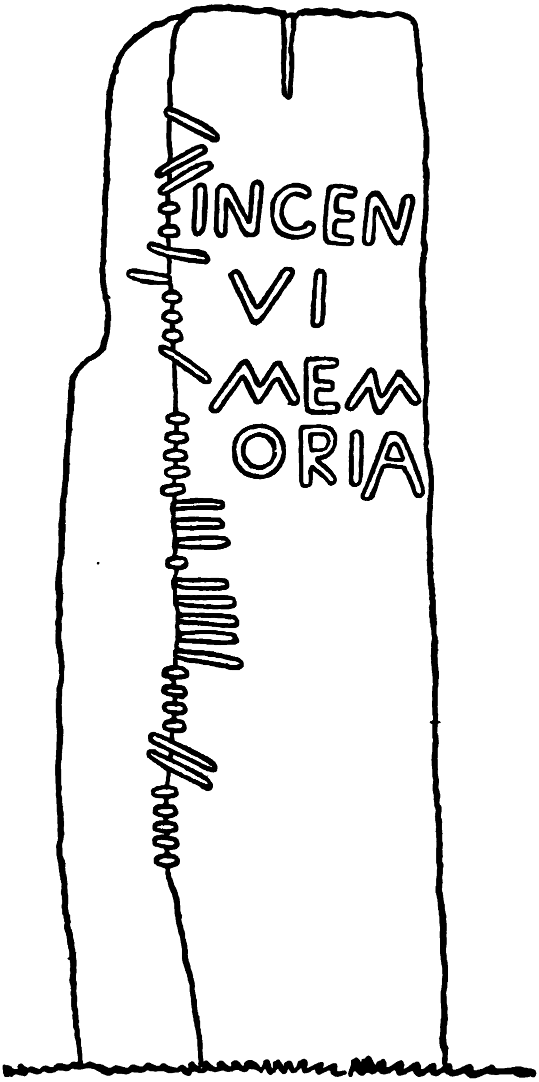
The stone is a rectangular block of granite, apparently deeply buried. The front is curved slightly inwards from top to bottom, and a portion of the back is split off in a similar manner to the "Other Half Stone" at St. Cleer.† There is also a vertical fracture at the top.

With the assistance of the sexton and a friend who accompanied me, I dug out the earth to a depth of 18 in. (a matter of some difficulty, owing to the roots of the tree), but no further traces of Ogams were found lower than about 9 in. beneath the surface. The height of the stone above the ground is 4 ft.; the width varies from 1 ft. 3 in. to 1 ft. 5 in., the greatest width being in the middle. Where the size of the upper portion of the stone is reduced by the piece being broken off, it is 5½ in. thick; the remainder is 9 in thick.

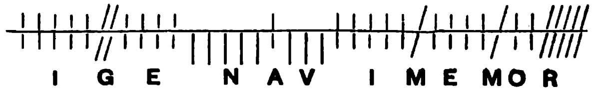
* Hubner's *Inscriptiones Britanniæ Christianæ*, Nos. 24 and 26.

† *Journ. Brit. Arch. Assoc.*, vol. xlvi, p. 325.

In addition to the Ogams there is an inscription in Latin capitals, which is quite distinct. It is cut in four horizontal lines, and reads thus:



The Ogams are cut on the right hand angle of the stone, and read from the bottom upwards, as follows:



This is merely a repetition of the Latin legend.* There is no difficulty about the reading as far as AVI, but after this it becomes somewhat obscure. The unusual position of the first two strokes of the final R may be explained by the necessity of avoiding cutting the initial I of the Latin inscription. The remaining strokes slope the right way after this difficulty had been got over. It is to be hoped that Prof. Rhys will give some notes on the inscriptions at an early opportunity.

The foregoing report appeared this year in the July number of the *Archæologia Cambrensis*, accompanied by this plate, for permission to use which I am indebted to the courtesy of the Committee of the Cambrian Archæological Association. Since the account was written I have again visited the stone, and have discovered that a slight error has been made in my reproduction of the Ogam inscription. In the last name the upright letter on the narrow face of the stone, on the right side of the Latin inscription, should have been drawn as a notch on the angle only; thus making four notches in all, equivalent to the letter *e*, as shewn in the diagram given in the letterpress. I also omitted to point out that Mr. J. Romilly Allen, F.S.A. Scot., to whom I sent the rubbings immediately after discovering the stone, must be credited for deciphering the inscription, and for observing the remarkable form of the *r* at the end of it, wherein the first two strokes of the letter slope the wrong way, for the reason already given.

The word MEMORIA in the Latin inscription is curious, and there is a great temptation to read the legend as TO THE MEMORY OF INCENVVS. If this translation were correct, the Latin to correspond should be INCENVI MEMORIAE; but as there have obviously never been any letters beyond the side of the stone, such a reading as suggested is, therefore, quite inadmissible.

* The only differences being that the Ogam inscription begins IG instead of INC, the A of AVI is missing in the Latin version, and the final IA in the Ogams.

Prof. Rhys, to whom I afterwards sent the rubbings, very kindly wrote to me on the subject, and as his opinion is of so much value, I have taken the liberty of inserting some of his remarks in connection with the word MEMORIA, especially that portion regarding the absence of the *e*.

It is in my opinion far better not to read a word at all, than to read it incorrectly, simply for the sake of making a translation of the whole legend, for which there is no justification. For the present, then, I at least must be content to let MEMORIA remain MEMORIA, without offering any solution as to the meaning of the word.

ANCIENT SETTLEMENT AT TREWORTHA.

BY THE REV. S. BARING-GOULD.

In the Journal of the Royal Institution of Cornwall for April, 1892, were published a notice and plans of some excavations made in 1891 on the site of an ancient settlement at the edge of Trewortha Marsh, on the Bodmin Moors.

A couple of days were spent in making further researches, in the spring of 1892, and one additional hut was in part cleared out. This is the hut marked B on the plan. It consists of a long chamber, measuring 29-ft. by 12-ft. 6-in., the walls composed partly of upright blocks, partly of stones laid in rude courses. It has its entrance on the west from a sort of vestibule to which admittance was obtained from the south. To the north this vestibule was probably closed by a wall, but no traces of its foundations could be discovered. On the west of this vestibule is a bakehouse, something like that already explored and described, Hut E It consists of a chamber measuring 9-ft. 10-in. by 12-ft. 6-in. Entrance was obtained from the east by a doorway, of which one of the uprights alone remains. The disappearance of this upright and of the wall of the vestibule adjoining may point to removal at a later period for the construction of a hedge or shed.

In the west wall of this chamber is a domed oven, the floor composed of a slab of granite. It was of bee-hive shape and constructed by the gradual contraction of the courses of stone. The top has fallen in. Adjoining it is a curious locker constructed in a curve, so that it might derive some of the heat from the oven. It is roofed over with four granite blocks.

A second hut, A, was but partially explored. It consists of two chambers that do not communicate with each other, that to the east has its walls lined with upright blocks, and has its door to the east, the western chamber has the door to the south, and its walls are in part laid in courses.

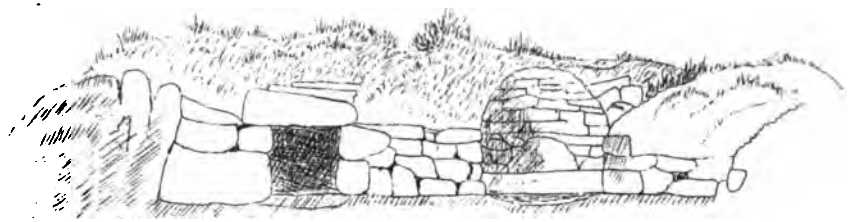
With regard to the relics found in this settlement, it is not possible from them to determine its age, further than that it dates from after the Roman Conquest. The pottery is rude, all of one type, and bears no trace of glaze. The fragments discovered point to wide-mouthed vessels, some of them with handles, but no spouts, so badly baked that some of the clay can be washed away as though it had never been subjected to the fire. Of ornament there is very little, what little there is was made with the finger or a bit of stick.

The discovery of several small hones shows that there were in use at the time iron tools; three or four flint flakes, and a scraper were found, also a circular button of slate, and a small granite quern.

A large quantity of the pottery, and the flakes and scraper of flint have been given by Mr. Robins Bolitho, the proprietor of the land, to the Penzance Museum.

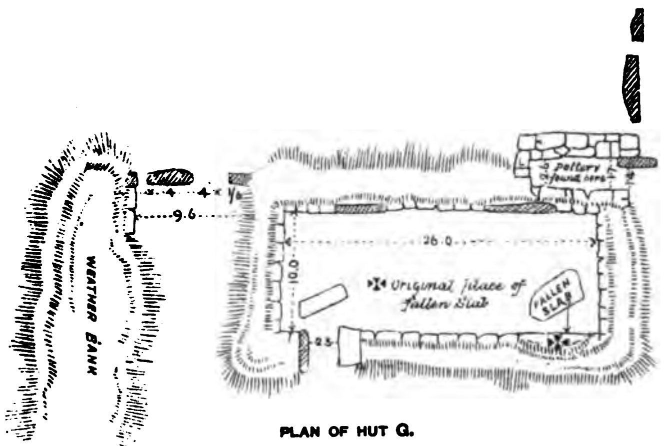
In the Journal of the Institution for 1868-70, is published a "Notice of enclosures at Smallacombe, near the Cheesewring," by Mr. J. T. Blight. These enclosures are situated about a mile further up the valley of the Withy Brook. They are of precisely the same character as those at Trewortha, and Mr. Bolitho is desirous that I should explore these, so as to arrive at some more definite conclusions as to the date of these perplexing remains.

On the hill slopes and tops around Trewortha are numerous cairns. Of these we have explored three. One was sliced through by the railway cutting, we found it contained a kistvaen, and under this a cup-like depression in clay containing ashes. A second, explored on a spur of hill dividing Tresillern Marsh from Trewortha, yielded nothing. A third, on the slope above Rushelford Gate, contained a granite cist enclosing ashes and burnt bone, but nothing further.

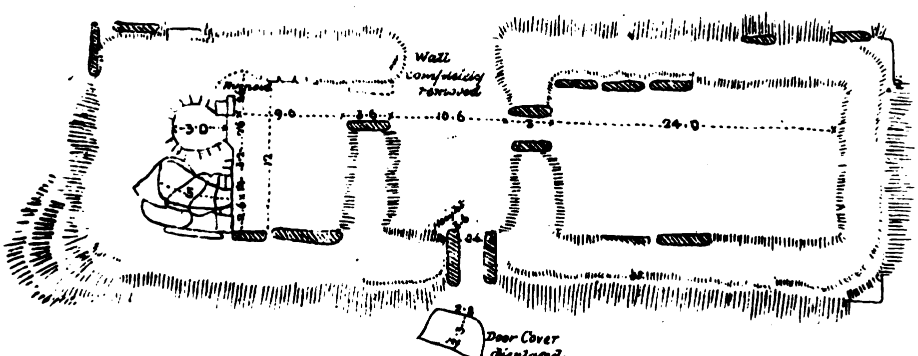


LOCKER AND OVEN IN HUT B LOOKING W.

SCALE OF FEET.

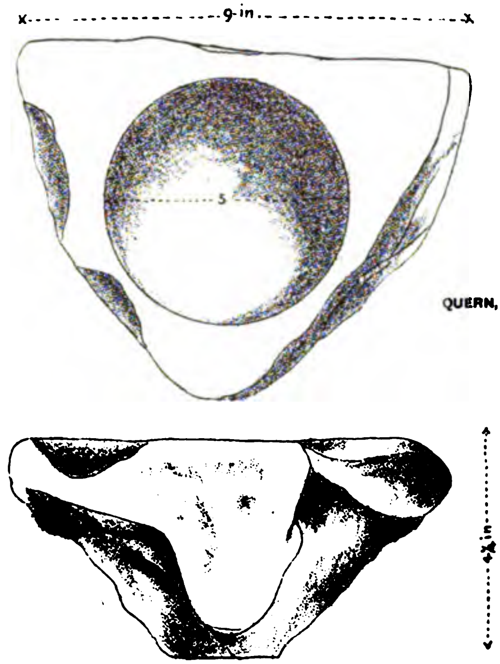


PLAN OF HUT G.

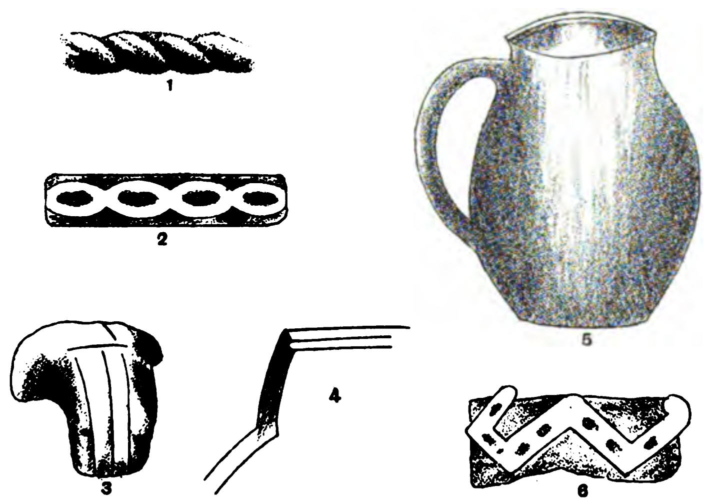


PLAN OF HUT B.

SCALE OF FEET.



QUERN, TREWORTHA.



SAMPLES OF ORNAMENT ON THE POTTERY.

1. *Border, made by twisted rope.* 2. *Border, ornament made with fingers and nail.*
3. *Handle fragment.* 4. *Section of fragment of lip of Pitcher.*
5. *Conjectural restoration of the pitchers, of which numerous fragments found, diameters of mouths usually 1-ft. 1-in. to 5½-in.*
6. *Fragment, uncertain to what sort of vessel it belonged.*

CORNISH LANDOWNERS WHO HELD 15 LIBRATES OF LAND OR MORE BY MILITARY SERVICE, AND WERE NOT KNIGHTS, HENRY III, 1256.

BY THE LATE WILLIAM SINCOCK.

INTRODUCTION.

Lysons, in his account of the principal Cornish landowners, says of this record (1255): "It includes *all those* who were possessed of fifteen librates of land, or more, and held by knight service." This is clearly erroneous, for the list of 13 names, is only of those qualified to take up knighthood, who had neglected to do so. Nor can they be rightly described *illustrious* men, as Sir John Maclean designates them in his history of the Manor of Hamatethy. *Witti filius Roberti* is supposed by him to be William Peverel, who gave the church of St. Breward to the Priory of Tywardreath. Apart from other considerations, showing the improbability of such being the case, it is notorious that the Peverel family were proud of their surname, and always used it.

The record is addressed to the king—"*Illustria viro, Domino Henrico, &c.,*" (*vide* Carew's Survey of Cornwall,) and was a return made by the Sheriff of those who held in Cornwall fifteen librates of land or more by military service, and were not knights.

The possession of a stated income from land at this time entitled to knighthood, and freeholders so qualified were compelled to become knights under penalty of a fine. A proclamation was issued that whoever had £15 and above in land, "should be dight in his armes" and endowed with knighthood, or be fined, "to the end that England, as well as Italie, might be strengthened with chivalry." Those knights in virtue of property, simply called *milites*, held a very different position from the *milites gladio cinesi* or knights whom the king had created by cincture of sword and belt.

Although only 13 names of the gentry of the county appear in this record, it is of great interest, as most of them can be distinctly traced to their respective families; and their descendants, in some cases, are still to be found among us.

1. *Thomas de Tracy* heads the list, whose lands in Cornwall are set down as worth 40 librates and more. The ancient family of Tracy can boast of descent from Saxon ancestors, being descended from the blood-royal of the Saxon kings of England, and possessing at the present day the same property as their Saxon ancestors did before the Conquest, viz.: Toddington, in the county of Gloucester,—a rare instance of William the Conqueror's forbearance.

LINEAGE OF TRACY.

King Edgar, by his second wife, Elfrida, dau. of Ordgar, Earl of Devonshire, was father of

Ethelred II, surnamed *The Un-ready*, who, by his first wife, *Elgifa*, dau. of the Ealdorman Thored, had six sons and four daughters. The youngest daughter, *Goda*, married Dreux, Count of the Vexin, a nobleman descended from Charlemagne, by his mother, Alice or Adele, daughter of Herbert, Comte de Senlis. By this marriage with Goda, the Count became Lord of Sudeley and Toddington, county of Gloucester, and left issue

Ralph, created Earl of Hereford, whose son,

Harold, possessed at the General Survey, numerous lordships in England, amongst which were Sudeley and Toddington, with the Castle of Ewyas and other lands in Herefordshire, secured, doubtless, by his intermarriage with Maud, daughter of Hugh Lupus, Earl of Chester. This Harold had two sons, John, his heir, and Robert, who had the castle of Ewyas, and assumed therefrom the surname of Ewyas. The elder son, assuming his surname from Sudeley, the chief seat which he inherited, became

John de Sudeley, and Lord of Sudeley and Toddington, A.D. 1140. He married Grace, daughter and heir of Henry de Traci, feudal lord of Barnstaple, and had issue

Ralph de Sudeley, founder of the priory of Erdburie.

William, who adopted his mother's name of *De Traci*. This William is (almost beyond doubt) the same Sir William Tracy who was concerned in the assassination of Thomas à Becket. He died *circa* 1224. By Hawise de Born, his wife, he left a son and successor.

Henry de Tracy, of Toddington, who died about the year 1246, leaving a daughter, Margery, wife of Maurice de Stanlich, and two sons, *Henry*, his heir, and Thomas, who became "*jure uxorus Isoldæ de Cardinan*," of Restormel Castle, Cornwall.

This *Thomas de Tracy* is the one named in our record. He married *Isolda* the heiress of the ancient baronial family of Cardinan. In 1256, certain proceedings were taken in the king's court respecting the dower of Ela, relict of Andrew de Cardinan, when Thomas de Pridias (Prideaux) was appointed attorney for Isolda, wife of Thomas de Tracy Andrew de Cardinan, the father of Isolda, was the son and heir of Robert de Cardinan, who held the baronies of Cardinan and Botardel, consisting of 71 knight's fees. In 1264, Thomas de Tracy surrendered the castle of Restormel, and the barony of Cardinan, to Ralph Arundell, to be held on behalf of Simon de Monfort, as a security against his enemies who had threatened him with destruction. In 1266, Thomas de Tracy witnessed a grant of Lanesley, in Gulval, by Simon de Als to the Prior of S. Germans. He died before 1269, for in that year, Isolda de Cardinan, as she styled herself, *who had been the wife* of Thomas de Tracy, conveyed the manors of Cardinan and Botardel to Oliver de Dinaunt; and also in the 54th Henry III (1269) Hugo de Treverbyn, quitclaimed the said manors to Oliver de Dinaunt for one sore hawk —*unum austurcum sorum*: a hawk of the first year. It is evident that Thomas de Tracy left no descendants. Lysons gives an ancient seal, appendant to a grant, without date, from Isolda de Cardinan to Henry de campo Arnulphi (Champernowne) of her manors of Tywardreath and Ludwon. On the seal is a coat of arms, three bendlets, with this inscription "S. Isonte de Cardinan." It is probable that the coat of arms on this seal was that of Tracy, the husband of Isolda de Cardinan, one of the coats commonly ascribed to the family of Tracy, being 2 bendlets.

2. *Roger de Mesy*—16 librates.

De Mesy is a name not known in Cornish history. The nearest approach to it is De Meules or Moels. *Roger de Meules* was returned, in 1297, as holding lands in Cornwall of £20 a year and upwards, but as he is stated to have died in 1294, his name must have been still retained in the king's books. This

Roger de Moels served in the Welsh wars, and in the beginning of Edward I's reign had the honour and castle of Lampadervaur, in Cardiganshire, committed to his custody. He married Alice, dau. and heir of William de Preux, and dying in 1294, was succeeded by his son, *John de Moels*, who, doing his homage in the same year, had livery of his lands. This feudal lord having distinguished himself in the Scottish wars of Edward I, was summoned to Parliament as a Baron, from 6th February, 1299. to 16th June, 1311. His lordship married a daughter of the noble family of Grey, and dying in 1311, was succeeded by his son, *Nicholas de Moels*, second baron. This nobleman also distinguished himself in arms. He married Margaret, daughter of Sir Hugh Courtenay, Knight, and sister of Hugh, Earl of Devon. His lordship died in 1316, and was succeeded by his brother, *Roger de Moels*, third baron, who died s.p., and was succeeded by his brother, *John de Moels*, fourth baron, whose daughter Muriel married Sir Thomas Courtenay, Knight, and Isabella, his sister and co-heir, married William (VII) de Botreaux, Lord Botreaux.

3. *Stephanus de Bellocampo*, 15 librates.

The Beauchams of Cornwall are considered to be of the same stock as those of Hache, in the county of Somerset; they bore the same arms—"Vairé az. and arg."

The first of this Somersetshire family of whom mention is made by Dugdale, is *Robert de Beauchamp*, who in 1162. 9th of Henry II, was sheriff of the counties of Somerset and Dorset. This feudal lord, died in 1228, leaving in minority his son and heir, *Robert de Beauchamp*, who died before 1251, and was succeeded by his son, *Robert de Beauchamp.* Of this feudal baron nothing is known beyond his being engaged against the Welsh with Henry III, and his founding the priory of Frithelstoke, in the county of Devon. He was yet living in 1257, and was ancestor of the Barons Beauchamp.

In Devonshire, we find in the 12th of John, that Guy de Beauchamp was sheriff. In Cornwall, the earliest known of this family is *Stephen de Bellocampo* (Beauchamp.)

In 47th Henry III (1263) a fine was levied in which John le Petit and Alice his wife were plaintiffs, and Stephen de Bellocampo, defendant, wherein Stephen granted to John and Alice,

Benherton (Binnerton in Crowan) and lands held of Robert Carminow. Alice, wife of Le Petit, with her sister, Emma, were coheirs of Mirabell (*née* Beauchamp?) once wife of Roger Durhull. Ped. fin. 33 Henry III. (1249).

The manor of Binnerton, the *Bennartone* of Domesday, belonged in the reign of Richard II to the Beauchamps; afterwards to the De Spencers. There was formerly a chapel at Binnerton dedicated to S. Augustine. One of the enclosures on the estate still bears the name of the chapel field.

(4.) *Henry, son of Henry de la Pombre*—30 librates.

We find the name of Henry de Pomerai or Pomeroy, in the records of 1165, and 1213-20, of which we have given an account. This is an instance of the transmission of the same christian name through several generations of the same family;—a common practice in many Norman families, notably in that of the Grenvilles, all the heirs-male of which, until 1295, bore the christian name of Richard.

It was to the *Henry de Pomeroy*, mentioned above, that Henry III, in 1266, granted a fair at Tregony on the festival of St. Leonard, (Nov. 6) which is still held.

According to tradition, Tregony Castle, of which there are now no remains, is said to have been built by Henry de Pomeroy (father or grandfather of Henry, of this record,) on behalf of John, Earl of Cornwall, at the time that king Richard I was in the Holy Land; it was standing, and was the seat of the Pomeroys, in 1478, when William of Worcester thus describes it—"*Castellum Tregheny stat, pertinet Pomereys, in Tregeny burgagio super le south.*"

(5.) *Robert de Carmeneu*—16 librates.

This *Robert* was, possibly, a son of that *Roger de Carminow*, who, about 1220, was witness to an undated charter relating to Trenant, and another charter, dated 1235, was witnessed by *Robert de Carminow* himself.

There is also in the muniment room at Coker Court, county Somerset, an undated deed, which, from internal evidence, would seem to have been made between the 20th and 30th Henry III, (1235 to 1245.) By this deed, *Robert de Kayrminou* gives and grants all his lands of Trewynian and of Bodanan which he

had of the gift of *Luke de Kayrminou*, to Thomas Peticru and his heirs, to be held of the said Robert and his heirs for homage and service.

According to "Testa de Nevil," in 1235, *Roger de Kayrminou* held one acre of land in Dobelboys, containing one carucate Cornish. He also was witness to an undated charter relating to Trenant, circa 1220, which is still in the muniment room at Tregothnan. *Robert de Carmeneu*, who held the 16 librates, was, perhaps, the father of Sir Roger de Carminow, who married Sara, daughter and co-heir of Gervas de Hornicote *alias* Tintaioel, and heir of her niece, Margery.

In 1263, Stephen Beauchamp assigns to Jno. Le Petit and Alice his wife, *inter alia* all the services of *Robert Carmynow* (*Vide* No. 3 De Bellocampo.)

"The Carminows, whose property, as well as the family, spread far and wide, both continuing to be esteemed among the first in the county, till the reign of Queen Elizabeth, appear on record here for the first time."—Lysons.

(6.) *Willi. filius Roberti*—15 librates.

In the Scutage-Roll, No. 2, *Robert Fitz-Walter* held 11 knights' fees of the fee of Richard de Lucy, his maternal grandfather, who died 1179, and it is owing to his marriage with Maud, eldest daughter of the Justician, that Walter Fitz-Robert, father of Robert, acquired his Cornish property. Walter died in 1198, and Robert, his son and successor, died at the siege of Damietta, in 1234.

We now, in 1256, find *William Fitz-Robert* holding 15 librates of land; and in 1261, Robert Fitz-Robert, probably a younger brother, was admitted, by Bishop Bronescombe, to the rectory of Gwinear, on the presentation of the Lady Jane Champernown, daughter of Thomas Champernown.

It was not until the reign of Richard II that the name of Fitzwalter appears among the Sheriffs of Cornwall, and then, in 1384, Sir William Fitzwalter, Knt., fills that office, and dies in the following year. His father, Robert Fitzwalter, married Jane, daughter and heir of Robert Fleming, by Hester, daughter and heir of John Berkeley, son of Sir Simon Berkeley, Sheriff of Cornwall 1287 and 1288.

Robert Fitz-Walter, in 30th Edward I, (1302) brought his Writ of Ael against Margery, "*que fut la feme de Richard le Flemeng*," at Launceston. The tenements were formerly in the seisin of one Robert de Hokyssahm (Hokisham) who died seised of the said tenements, after whose death, the said tenements with others descended to this Margery and one Maud as daughters and one heir; from Maud descended the right of her purparty to one Gilda as daughter; and from Gilda to one William as son, who is under age; and we pray aid of him. (Year Book 30 and 31 Edward I, p. 230.)

From the above we learn that Robert de Hokisham had two daughters—Margery, who married Richard le Flemeng, and Maud, who married * * * * and had a daughter Gilda, who married * * * * and had a son, William, then under age, on whose behalf Robert Fitz-Walter brought his writ.

In 1338, when an account was taken of the knights' fees belonging to the Honour of the Castle of Launceston in the hands of the Duke,—"Johanna, who was the wife of William, son of Robert, holds half of one fee in Penros." This entry refers to Johanna, wife of William Fitz-Walter, son of Robert Fitz-Walter, holding half a fee in Penrose-Burdon. By Margaret, daughter and eventual heir of William Fitz-Walter, the manor of Penrose-Burdon was conveyed in marriage to the family of Wibbery, from whom it passed through the Bonvilles to the Coplestones; by the latter it was alienated, in 1592, to Billing, *alias* Trelawder, of Hengar. It remained in the name of Billing until the death of John Billing of Hengar, in 1688. His daughter and heir carried it in marriage to the family of Lower, from which family through the Michells, it passed to the Onslows, the present possessors.

Early notices of Fitz-Robert occur in the time of Henry II, John, and Henry III, in charters undated and dated, relating to Cornwall. (1) In the grant by William Peverel of the church of St. Breward to the church of St. Andrew, Tywardreath, and the monks there serving God, five sons of Robert are among the witnesses—William, Walter, John, Stephen, and Richard. In the same charter, Andrew, the Prior, concedes to William Peverel and his heirs to have divine service performed three times

a week in his chapel at Hamatethy by the mother church, whenever William or his wife should be present. This is also witnessed by William and Walter, *filiis Roberti*. Probable date, 1170.

(2) The next charter is a confirmation of the church of Minster by William de Botreaux, of the gift of his ancestors—witnessed by William and Walter, sons of Robert, undated, probably *circa* 1205. (3) In the charter of Henry III, dated May 6th, 1234, ratifying the grant of Robert de Cardinham to Tywardreath Priory, the parish of Lelant, with the villages of Lelant town and Tredreath, and half-an-acre of land, is included. This grant is recognized by Geoffry Fitz-Robert of Trembethow, in Lelant—"*Gaufridus filius Roberti de Trembedhov.*"

This throws light upon an entry in the Book of Aids, 20th Edward III, when the aid was levied for knighting the king's eldest son, in which Johanna, wife of William *Tremblethou* is mentioned, which William, in right of his wife, held a half fee in Penrosburden. We know the husband of Johanna was *William Fitz-Robert*, and consider that Trembethow, in Lelant, was their seat, giving name to the Fitz-Roberts at this early period.

(7.) *Marc le Flamanc*—16 librates.

In 1165, *Erkenbald fil. S*— (Stephani) is mentioned in the Public Records relating to Cornwall. In 1196, *Stephanus Flandrensis*: and in 1213, *Archemaund Flandrensis* are in the Scutage-Rolls. *Archenbald le Fleming* is also recorded in Testa de Nevil, p. 201, as holding, in 1235, several small fees in Bray, county of Cornwall, with appurtenances in Devon. In 1256, Archenbald was probably dead, and was succeeded by *Marc le Flamanc*. This Marc was perhaps the immediate predecessor of Sir Robert (? Roger) le Flamanc, Knt., who was Lord of Nantalan in 1294. This manor has recently been called Nanstallen, and has, for six centuries, been vested in the Flamank family. There are several ancient court rolls of this manor in the possession of the family. In the reign of Edward II, Mark Flamank, son of Sir Roger, was seized of a tenement in Boscarne bighan, Little Boscarne, near Bodmin, as appears from the Assize Rolls of 40th Edw. III (1367).

Lysons says, in his remarks on this record, that "the name of the Flamanks still continues, although most of the landed property has passed to the heiresses of elder branches." The manor of Bray, in Morval, is said to have been sold before 1564, by Christopher Coplestone, who was Sheriff of Devon in 1560. He was descended, through females, by 10 generations from Robert Fleming, who married Hester, daughter and heir of Jno. Berkeley. Their daughter and heir, Jane, married Robert Fitz-Water, father of William Fitz-Water, Sheriff of Cornwall, 7th Richard II.

(8.) *Willi. Wise*—16 librates.

Greaston or Greston, in Lezant, was the ancient seat of the *Wysea* or *Wise* family, afterwards of Sydenham, in Marystow, Devon.

William Wysa was one of the witnesses to a deed made by Richard de Landu, of Lezant, without date, but evidently of the period of this record, as the custom of affixing dates to deeds was not become general in the reign of Henry III. Another deed, without date, but somewhat later, as Thomas, son of Richard de Landu, is named, was executed by *Sir William Wysa*, of *Greyston*, probably *circa* 1270. In it he granted to William, son of Warine de Landu, "all my right that I had, or could have, to one pair of white gloves, with homage & service, which Thomas, son of Richd. de Landu, & his heirs or assigns, were wont to pay & to do yearly, unto me & my heirs & assigns at the Feast of St. Michael, for that half acre of land which Willm. Fridey formerly held in the vill of Landu."

Constance, daughter of William Wise, of Grayston, married William Godolphin (Visitation of Cornwall, 1620, Godolphin Ped.).

After leaving Greston, the Wise family removed to Sydenham, near Tavistock, where they resided until the reign of James I, at whose coronation, in 1603, Sir Thomas Wise received the honour of knighthood. His only son, Edward, dying unmarried, "his grand-daughter in the female line, Mrs. Bridget Hatherleigh," by her marriage with the gallant royalist, Col. Arthur Tremayne, carried the house and lands of Sydenham to the family of Tremayne.

(9.) *Jordanus de Hacumb*—14 librates.

Haccombe is two miles east of Newton Abbot, in Devon, and gave name to a family which, at a very early period, possessed this property. It is a question whether the original name of the family was *Fitz-Stephen*, or *De Haccombe*. In 35th Edw. I (1306) at the Assizes then held at Launceston, William (VI) de Botereus (Botreaux) recovered from *Cecelia de Haccombe*, *Stephen de Haccombe*, and others, one water-mill, &c., in Castelboterel, which Cecilia claimed as a part of Worthefala (Worthevale), which she held in dower of the inheritance of the said William de Botereus, and by his assignment. John Lerchedekne, 2nd baron Archdekne, who was born in 1306, married *Cecilia*, daughter of *Jordan Fitz-Stephen de Haccombe*. This Cecilia, it is evident, could not have been the claimant of dower in 1306, mentioned above. By this lady, his lordship had nine sons, of whom Warine succeeded him as 3rd baron. Dying in 1400-1, his second daughter and coheir, Philippa, born 1386, in 1407 was second wife of Sir Hugh, second son of Edward Courtenay, of Godlington, who was second son of Hugh Courtenay, second Earl of Devon. By Philippa, Sir Hugh Courtnay had an only daughter, Joane, whose first husband was Nicholas, Lord Carew, of Mohuns Ottery, and thus Haccombe became the property of the Carews, resident there for the last 450 years. Sir Nicholas Carew, Knight, commonly called Lord Carew, died in 1449.

Returning to Sir John Lercedekne, Knight, husband of Cecilia de Haccombe, we learn that in 1341, he endowed the chantry of Haccombe with the great tithes of *S. Hugh de Quedyock*, in conformity to the wishes of Sir Stephen de Haccombe, Knight, who had applied to Bishop Grandison (cons. 1327, ob. 1368.) to erect the parish church of St. Blaize at Haccombe, the burial place of his ancestors, into an Archpresbytery, but, before his request could be complied with, the good knight died. In Oliver's Historic Collections is printed the foundation deed of this college. The community, besides the Archpriest, consisted of 5 clergymen, called *Socii*. They were bound to sing the canonical office, and to celebrate obits. All dwelt under the same roof, and lived in common. The archpriest had to pay annually six marks to the treasurer of the cathedral of Exeter. The living of Quethiock is a vicarage; the tithes were commuted

in 1842, at £686 1s.—viz. to the Vicar, £342 9s., and to the rector or chantor of Haccombe, £343 12s. The church at Haccombe, dedicated to S. Blaise, contains, in fine preservation, many interesting monuments of the Haccombes and Carews.

(10.) *Robertus de Draenas*—15 librates.

No family of this name is to be found in any Cornish record, and bearing in mind the fact that the spelling of names in these ancient records is very erroneous, we must have recourse to probabilities, and find some family of importance, at this period, with the christian name of Robert. *De Draenas* we take to be *De Pridias*. Draenas has the same number of letters as Pridias: the initial letter D may be a mistake for P, the second, sixth, and seventh letters are identical.

Robert de Pridias was the son of Sir Thomas de Pridias, Knt., who, in 3rd Henry III (1218) was placed in remainder in default of issue of John Bevill and Agnes his wife, *inter alia*, in the manor of Wolfyston, county Cornwall. His mother was Jane, daughter of Philip Brodrygan (Bodrigan). This Philip had a brother Reginald, who was attorney for him in 1253.

Robert de Pridias granted to the monastery of Tywardreth certain lands in Frank Almoigne.

The family of *De Pridias* (Prideaux) held the manor of Predeaux of the Priory of Tywardreth. Baldwin de Pridias, who died 1165, had a grant in fee of the manor of Prideaux from Osbert, Prior of Tywardreth. The last heir-male of the elder branch of this ancient family died 11th Richard II (1388); his daughter and heir, Jane, married Philip Arvas, whose granddaughter, Johanna, brought the manor of Prideaux to the Hearles of West Hearle, in Northumberland, a branch of which family resided in Cornwall. At the death of Northmore Herle, Esq., of Landew, in 1737, he bequeathed this manor with other property to his six half-sisters. Eventually Prideaux was sold in 1806, to the Rashleigh family, who are the present proprietors.

(11.) *Philippus de Valletorta*—40 librates.

This ancient baronial family became extinct in 1289, when Roger de Valletort died, bequeathing his large landed property to his two sisters. One, Isabel, married first Alan de Dunstan-

ville, second Thomas Corbet, Sheriff of Shropshire, in 1249; the other sister married Pomeroy of Berry-Pomeroy, county Devon, and Tregony Castle. Roger had, 14 years before his death, resigned his right and interest in the manor and castle of Trematon to Richard, Earl of Cornwall, after Corbet and Pomeroy, descendants of the two sisters, had petitioned for the recovery of the manor and honor of Trematon, alleging that Roger when he made the deed of gift in favour of the Earl, was not *compos mentis*; their suit was without success in 1315, and renewed in 1327 with like result. Finally, in 1339, Henry de Pomeroy, in consideration of an annuity of £40, released to Edward the Black Prince, all right and title as heir of Roger de Valletort to the honor and castle of Trematon.

(12.) *Richard de Grenuile*—50 librates.

The largest landowner named in this record, which, it must be remembered, is only a list of 13 persons of full age who were required to take up knighthood, is *Richard de Grenville*. His mother, it is reasonably supposed, was the heiress of Thomas Fitz-Nicholas de Middleton. Although long settled in Devon, this is the first time that the name of Grenville appears in Cornish records. Until 1295, all the heirs male of the Grenville family bore the christian name of Richard. The owner of 50 librates, succeeded his father, *circa* 1217, and is supposed to have married Jane, daughter of William Trewynt. In consideration of a fine, levied 22 Henry III, 1237, he conveyed the advowson of the church of Kilkhampton, and the advowson of the church of Bideford, in Devon, to Ralph, abbot of Tewkesbury. Notwithstanding, he, on April 26, 1261, presented Henry de Bratton to the rectory of Bideford. At his death he left two sons, both in their minority, Richard and Bartholomew.

(13.) *Henricus de Dones*—15 librates.

Tonkin takes this *Henry de Dones* "to be the same with Dawney." We are disposed to consider *le Daneys* the family named, and that *Dones* should be *Danes*.

The manor of Lesnewith, together with the advowson of the church thereto annexed, was, in the 13th century, in the possession of the family of Denys, then styled *Le Daneys*, who held of the family of Pomeroy as of their manor of Tregony.

In the 22nd Henry III (1294) Fulco, Abbot of Valle, suffered a fine for himself and his church of Valle, to *Henry le Daneys*, in the advowson of the church of Lysnewyth, reserving to himself and his successors, and the church of Valle, the ancient pension by custom payable out of the same, and from that time the rectory has been appurtenant to the manor of Lesnewith. *Henry le Deneys* was rector in 1297, and was one of those clergy who, in that year, in obedience to the Pope, Boniface VIII, refused to pay the subsidy levied by the king. Benedict Reynward, a large dealer in tin about this time, became surety for the payment of the fine which the rector was compelled to pay for obeying the Pope's bull. This important manor continued vested in the family of Denys until the death of Anthony Denys of Orleigh in 1641, leaving by Gertrude, his wife, daughter of Sir Bernard Grenville, three daughters.

SOME REMARKS ON THE PELAGIC LIFE OCCURRING IN AND NEAR FALMOUTH HARBOUR, WITH ADDITIONS TO THE FAUNA OF THE DISTRICT.

From August, 1891, to December, 1892.

BY RUPERT VALLENTIN.

1. PELAGIC LIFE.

Since my last report (10)* my attention has been mainly directed to the study of the pelagic life occurring in and near Falmouth harbour.

When commencing my investigations in 1890, I saw that the direction of the wind and strength of the tide played most important parts in my surface collections; and that in order to make the best surface-net gatherings, information relating to the tidal currents in the harbour and on the coast outside would have to be obtained. Since that time I have consulted pilots, fishermen, and others on the tidal currents both in the bay and harbour, but have experienced the greatest difficulty in sifting the evidence; for in the majority of instances my informants flatly contradicted each other. I am in hopes however that within another year, I shall be in possession of sufficient reliable information to enable me to construct a series of charts, shewing the principal changes of the currents in and near Falmouth harbour. Speaking generally, given a south-westerly wind and a rising tide, a strong current from the Lizard sweeps into Falmouth bay round the Manacle rocks, and from thence into the harbour; the main body of water flowing into the latter between the Black rock and St. Anthony point. On the other hand during an ebb tide, pilots when sailing a vessel into the harbour, particularly if the wind is at all light, never allow the vessel to occupy a position south of the Zoze point; as the tide at this stage would sweep the ship into Gerrans bay. This statement receives confirmation from personal observation. During the summer, when the wind is blowing from the north to

* See references at the close of paper.

north-west, I have frequently seen Gerrans bay swarming with specimens of Aurelia aurita. On these occasions one may hunt in vain in Falmouth harbour for specimens of this species.

Up to the spring of the current year my only craft for collecting purposes was a small open eleven-foot sail and rowing boat, in which it was not prudent to venture more than a few miles from shore. On discussing this matter with my friend, Mr. A. Ingram, last winter, he strongly advised me to obtain a double centre-board canoe, and on his return to London kindly sent me designs and full instructions for building a canoe according to his ideas. During the early part of the present summer the boat was launched. I think it would be difficult to find her equal, not only for sea-going qualities, but also for sailing capabilities; and I gladly take the present opportunity of thanking him for the trouble he has taken.

I also have to thank my friends Mr. J. T. Cunningham and Mr. Walter Garstang, both on the staff of the Marine Biological Association of the United Kingdom, for their valuable assistance to me on occasions too numerous to mention.

As I have already published a list of the various species of copepods and other forms usually to be found in the sea near Falmouth, I propose in my present communication to make some extracts from my note-book; recording the variations in the temperatures of the sea, and forms of interest captured from time to time in my tow-net.

August, 1891. During this month the surface temperature of the sea was very low, and ranged from 58°F on the first of the month to 57·6° F on the 29th.

On the first of the month after a considerable interval, a few specimens of Corycœus anglicus occurred in the surface-net gathering made on that day. Actinotrocha, the beautiful larva of Phoronis, was fairly abundant in surface-gatherings throughout the month. Noctiluca miliaris had been fairly abundant in the sea since the beginning of the year up to the present time. On the 6th of the month northerly winds set in, which swept these surface forms out to sea, and by the 17th, this species vanished from the neighbourhood for a considerable time. On

the 8th, a few specimens of Sarsia prolifera were captured. So far as I am able to discover, this species has hitherto escaped the notice of local naturalists. On the 15th, a few Tornaria in an advanced stage of development were captured in the surface-net. On the 26th, a single specimen of the interesting Pteropod, noticed in my previous report, was secured, the wind on that occasion being from the westward.

September. There was not much variation in the surface temperature of the sea during this month. On the first, the surface temperature was 56·9°F, and on the 30th, 57·6° F. On the 2nd, a single male specimen of Centropages typicus, and one small specimen of Monstrilla rigida were secured. The most interesting specimen obtained on that occasion was one Campontia eruciformis figured and described by Dr. Johnston (7). Since then I have caught not only in my surface-net, but also during shore collecting, four more specimens of this interesting animal. The reason it is found in surface-net gatherings is, I imagine, that during gales of wind it is dislodged by the force of the waves from its usual habitat at the roots of sea-weeds; and on finding itself at the mercy of the currents, clings to the nearest fragment of weed till left stranded again by the tide. Dr. Johnston, *loc. cit*, is of the opinion that this animal is not the larva of a dipterous insect. Mr. Gosse (6) in his excellent manual writes concerning it as follows :—" There is, however......the larva of some two-winged fly, which is marine. I have repeatedly taken it on our southern shores, quite out of the influence of fresh water. That my specimens are those of a Dipterous larva, I have the high authority of Mr. Francis Walker, who has examined one." After careful examination of the few specimens I have captured of this species, I have no hesitation in stating that Mr. Gosse's remarks are correct. I have invariably seen in my specimens a distinctly paired longitudinal tracheal vessel, which is placed in the lateral body wall, and which appears to open to the exterior by a paired opening on either side of the anus. The attempts I have made by means of serial sections to determine this point, have so far been failures, owing to the thickness of the cuticle of the animal; but I am in hopes at some future date of making some further study of this animal.

During the calm summer evenings this year, I have frequently observed two species of dipterous insects flying just on the surface of the sea, and also hovering on the rocks forming the Black rock, when left exposed by the tide. After some considerable difficulty I captured a few specimens of both species, but so far I have been unable to identify either.

Mr. Julien Deby (3) has recorded the capture of a marine dipterous insect at Biarritz, and has named it Psamathiomya pectinata.

On the 4th of this month one female Monstrilla rigida with ova attached was secured in the tow-net; and in the same gathering specimens of Evadne nordmanii and Podon intermedius occurred in abundance. On the 9th there was a light easterly wind blowing, the surface temperature being 57·9°F, and the tide one hour on ebb. On that morning I worked the surface-net in two places with a view to study what effect the wind had on surface forms. The net on the first occasion was worked across the tide from half way between the Black rock to St. Anthony's point. There was in this gathering a fair quantity of the following forms :—Larvæ of Decapod crustacea, Cyphonautes, medusiform stage of Obelia gelatinosa, and some common species of various copepods. The net was then worked along the southern edge of the Eastern breakwater, amid the debris blown thither by the wind. In this locality, in addition to the forms above mentioned, I noticed in the gathering a single specimen of Monstrilla and several specimens of the Pteropod. On the 11th, the only interesting specimen noticed in the gathering was a single larval form of Eucratea chelata. From the 12th to the 17th, the species of Peridinium, recorded in my last report, literally swarmed in the upper portions of Penryn creek. About the 20th, a very interesting species of Infusorian, new to me, was very abundant in the sea in the neighbourhood of Flushing. After a careful examination of several specimens, I have identified it as Prorocentrum micans figured and described by S. Kent (8.) At this time I had occasion to examine the crystalline style of several specimens of Ostrea edulis from that locality. I was astonished to find imbedded in the crystalline style quantities of Prorocentrum micans; but I hunted in vain to find a single specimen of Peridinium in that

structure. On the 25th, the only form of interest taken was a single male of Pontellia wollastonii. On the 26th, after strong winds from the west south-west, the tide being three-quarters flood, and surface temperature 57°9 F, I collected a fair quantity of a species of Siphonophore quite new to me. On the 17th of October following, my friend Mr. Cunningham wrote to me as follows:—"Do you know I have been taking immense numbers of Siphonophores in the tow-net for the last month or so? They have only one swimming bell or nectocalyx, and belong to the genus Muggiacea." Later, Mr. Cunningham published (2) a short paper with two figures of this Siphonophore, and named it Muggiœa atlantica. On comparing my sketches with his illustrations, I have no hesitation in stating that our specimens are identical.

October. The surface temperature of the sea on the 2nd was 57°6F, and on the 21st 53°F. On the 8th numerous specimens of the Pteropod were again secured in the surface-net, and with them a fair quantity of Tintinnus ampulla occurred. On the 20th, the wind was fresh from the south-west, and tide one hour on ebb, when the surface-net was worked, the temperature being on that occasion 55°F. I found in the collection, in addition to the usual forms, a number of Ceratium tripos, and with them a single specimen of a species of Radiolarian. I have tried to name this single specimen, but my attempts have so far been unsuccessful. This is the only occasion I have ever secured a specimen of Radiolarian in my tow-net during my residence in Cornwall.

November. During the early part of this month we had gales of wind from the south-east and east, and it was not until the 5th that I was able to venture out in my boat surface-netting. The surface temperature on that day was 50° F. The only forms of interest captured on that occasion were quantities of Sagitta and Corycœus anglicus. From the 6th to nearly the end of the month, I was unable to do any surface-netting, owing to an attack of Influenza. On the 30th, when I resumed my investigations, I found the surface temperature had fallen to 46°F. An examination of the gathering made on that day, shewed that Evadne and Podon had vanished from the surface for a time. On the other hand, Sagitta occurred in profusion.

December. On the 4th of the month, surface-temperature was 51°6 F. I took this temperature twice, for it occurred to me at the time, what a great rise there was in the surface temperature, but with the same results in both cases. On the 16th, the wind was from the south-east, surface temperature at 11 a.m. being 51°F. The tide was three-quarters ebb when the surface-net was worked off the Zoze point. The most interesting forms secured were two specimens of Calanus finmarchius, and what I at first imagined to be a single specimen of Mysis. On returning to my hut, a close examination of this specimen shewed me that I had caught a species of shrimp with luminous organs, called Nyctiphanes couchii. This solitary specimen measured 11 m.m. in length, and seemed to be in the same stage as those captured in abundance off St. Abbs Head by Mr. Cunningham and myself in a tow-net during June, 1887. On the 21st, the only form of interest obtained was one specimen of Anomalocera patersonii. The surface temperature on that occasion was 46°F.

January, 1892. The wind during the greater part of this month was from the north, and as a natural consequence, the surface-net gatherings were neither rich nor varied. The surface temperature on the 1st was 49°3F. On the 18th, surface temperature being 47° F, a fair quantity of the free swimming larvæ of Chiton were captured in my tow-net. A few days later, when collecting at low water under the Eastern breakwater, I found attached to the balks of timber innumerable quantities of capsules deposited by these mollusks. Towards the end of the month Oithonia spinifrons occurred in profusion in tow-net gatherings.

February. Surface temperature on the 1st was 46°F. On the 5th, I noticed in my tow-net gathering made on that morning the first trace of the gelatinous alga recorded in my previous report. On the 15th, the surface temperature had risen to 48°F. During this month specimens of the ephyra stage of Aurelia occurred very sparingly in tow-net gatherings, and as a natural consequence, Aurelia aurita, the adult animal, has been quite scarce in the harbour this summer. On the 23rd, I noticed that several females of Oithonia spinifrons had ova attached. Towards the end of the month the surface temperature of the sea had fallen to 44°6 F, the weather at that time being very cold and stormy.

March. Cold, wild weather prevented my getting afloat till the 8th. The surface temperature on that day was 40°·6 F. The only forms of interest secured on that occasion were large quantities of Sagitta, averaging three-quarters of an inch in length.

Since the 15th of last month the gelatinous alga had been slowly increasing in quantity in the sea up to this time. On the 17th, however, a rapid increase set in, and by the 21st, the gelatinous alga was plainly visible in the sea, even to the most casual observer. On that day a rise took place in the surface temperature, 45°F being the temperature recorded. During this time the zoaea stage of various species of decapod crustacea was very abundant in the sea. On several occasions I have purchased from men catching smelts near my hut a few of their fish in a living condition. In addition to the fragments of potato, by means of which the men capture them, I have been able to recognize partially digested specimens of Sagitta, and zoaea stage of decapod larvæ in their stomachs.

On the 21st, I secured a single specimen of Arachnactis albida. The surface temperature on that day being 45°F. On the 24th the larvæ of Balanus abounded in the tow-net. From that day till the beginning of June surface-netting was impossible, owing to the abundance of the gelatinous alga in the sea The surface temperature varying during this time from 50°F to 53°F.

In my previous report, I directed attention to the fact that, so far as my experience had gone, when these gelatinous bodies were most abundant in the sea, Noctiluca miliaris also abounded. My observations this year showed that this statement is not correct. This year, during the time the alga was so very abundant, specimens of Noctiluca were never seen. Indeed, it was not till the 15th of November that any specimens of this species of Infusoria were seen in tow-net gatherings; and even then they were but sparingly present.

June. It was not till the 2nd of this month that I was able to resume my surface-net investigations. The surface temperature of the sea on that day was 53°F. On examining the contents of my surface-net gathering made on that morning, I found that Evadne nordmanii and Podon intermedius were fairly

abundant, and with them specimens of various common species of copepods, the only interesting form among them being one Monstrilla rigida. On the 7th, a few specimens of Cyphonautes were noticed. On the 13th, while sailing in my canoe to St. Mawes on a shore hunting expedition, I noticed in the sea some beautiful specimens of a species of Ctenophore new to me, swimming just beneath the surface of the water. I managed with a hand-net to capture some specimens of this species, as all those collected with a surface-net were invariably damaged. A short time later, as I was unable to identify this Ctenophore, I sent some rough sketches to Mr. Garstang, who kindly replied to my queries as follows :—...... "I was much interested in your queries after my paper read at the Devon Association, because your "Fig. 1" is certainly one of those which I described to them —a Ctenophore of the Lobate Order, Genus Bolina. The species is not quite certain, but it is probably hydatina of Chun, and also probably alata of L. Agassiz.....They appeared in the Sound in great numbers on May the 28th, and a few were seen on the 27th and 29th."

Although I was not using the surface-net on the dates mentioned by Mr. Garstang, owing to the presence of the gelatinous bodies in the sea, I feel fairly confident that these Ctenophores did not then occur in Falmouth harbour in any quantity. All that time I was industriously engaged shore-hunting in various parts of the harbour, and I feel confident that so prominent an object as this Ctenophore would not have escaped my notice. Be that as it may, after the 15th of this month I was unable to secure any more specimens of this beautiful species.

On the 16th and two following days, I captured in the surface-net a few specimens of the free larval form of a species of Synapta. The only description I have been able to discover relating to the later stages of this species is by Mr. W. Thomson (9). I made some drawings of my specimens, and also placed about a dozen of these larval forms in a jar with a slow current of water always passing through it. In spite of all my care, in a few days all these specimens died. During this month specimens of Thaumentias pilosella, already recorded by Dr. Cocks, were very abundant in tow-net gatherings, made not only

in the harbour but also in the open sea. Owing to the fragile nature of this species, it is difficult to collect perfect specimens in the harbour. On several occasions I was able during this time to capture perfect specimens of this species about three miles south of the Zoze point. On the 27th, a few Auricularia larvæ were obtained. On the 30th the surface temperature was 56·3°F. On that day, specimens of Appendicularia were exceedingly abundant in the tow-net.

July. On the 4th the surface temperature was 56·3° F. During this month Appendicularia continued to be very abundant in my tow-net gatherings. On the 7th, the following species of naked-eyed medusæ were to be found in large quantities: Sarsa tubulosa and Thaumentias hemispherica, both recorded by Dr. Cocks; Lizzia octopunctata, which at times was swarming in the sea, appears to be new to the district. In the same gathering occurred two specimens of Monstrilla rigidia, to one of which ova were attached. On the 11th I took several Lizzia blondina. In the same gathering a single specimen of Campontia eruciformis was observed. On the 13th the surface temperature was 59·9°F. On that day I got several specimens of a species of medusa, quite new to me. I made some careful drawings of one or two, and finally sent some of the sketches to Mr. Garstang; but he was unable to identify the specimens. Examples of this species continued to be fairly numerous in surface-net gatherings from that date till the close of the month, when they suddenly vanished. On the 16th several larvæ of Eucratea chelata were again secured. On the 21st a few Sagittæ were captured in the tow-net, the gonads of all the specimens examined being empty. On the 28th we had easterly winds in the morning, surface temperature being 60° F. The gathering made with the surface-net across the rising tide on that morning was very rich in results. Zoæa and megalope stages of species of crustacea, Centropages typicus, males only, various species of Plutei, Oithonia spinifrons, Evadne, Podon, Cyphonautes, and various species of spinid larvæ were all abundant. In this gathering I observed a single specimen of Tornaria in a very early stage of development. On the 30th, Pilidium began to appear in tow-net gatherings, surface temperature on that day being 61·9°F.

August. During this month the surface temperature of the sea varied but little. On the 6th, surface temperature being 61·9°F, Pilidium and Auricularia larvæ were very abundant in the tow-net. In the same gathering I secured a single specimen of what I imagine to be an advanced larval form of a species of Holothurian. I made two drawings, and later cut some serial sections of this specimen, but in spite of all my efforts I was unable to identify the animal. On the 8th, the wind blowing fresh from the south-south-east, surface temperature 61° F, and tide three-quarters ebb, two specimens of Muggiœa atlantica were found for the first time this year in the tow-net gathering. I also noticed that Oïthonia spinifrons was very abundant. During this time some very large specimens of Chrysaora mediterranea were seen just under the surface of the sea in various parts of the harbour, and also in the bay. I have several years ago seen this species very abundant in the sea near Newquay. On the 11th the surface temperature was 60·9° F. A single specimen of Corycæus anglicus and one very early stage of Actinotrocha were the only interesting forms captured on that day. During the rising tide on the 15th, the wind being fresh from the south-west, and surface temperature 61·3° F, a very rich gathering was made with the tow-net. Muggiœa atlantica occurred in profusion, and continued very plentiful in surface-net gatherings for some time later. During this time cypris stage of Balanus, Lizzia octopunctata, Sarsia tubulosa, and S. prolifera were very abundant in the tow-net. The latter portion of this month was very wild and quantities of rain fell.

September. On the 1st, the wind being from the south-west and blowing fresh, a considerable fall in the surface temperature was noticed, 57·3° F being surface temperature on that morning. On this occasion Corycæus anglicus occurred in abundance; a single female of the same species with ova attached being noticed. In the same gathering large numbers of Sarsia gemmifera occurred. On the 5th the wind was light and variable, surface temperature being 57° F. In the gathering made on this morning, only one specimen of Corycæus anglicus was seen. I also noticed in that gathering a few specimens of a species of Lizzia which I have been unable so far to identify.

On the 10th the wind had changed to the north-west, and as a natural consequence the surface-net gathering was not very rich in species. A few specimens of Oithonia spinifrons and Sagitta were the only forms whose presence called for any notice, surface temperature on that morning being 56° F. On the 15th a favorable opportunity occurred for a surface net trip seven miles from land. Hitherto three or four miles from shore was the greatest distance I deemed it prudent to venture in my canoe. During the two or three previous days the wind had been blowing steadily from the south to south-west, and it seemed to me most probable that if the surface-net were worked in localities removed from shore currents, some interesting, and perhaps new forms might be secured. My trip was a failure. At the point most distant from land, specimens of Sagitta occurred in abundance. On all the other occasions this form was absent from the tow-net gatherings. All the other forms captured were familiar to me, and in reality were not so varied as those caught nearer the shore. Surface temperature was 57° F. On the morning of the 19th the surface temperature was 57·9°F. In my tow-net gathering made on that morning a quantity of Tornaria and Pilidium were secured. In the same gathering two specimens of Actinotrocha were noticed. Oithonia spinifrons and Centropages typicus were also fairly numerous. On the 22nd the wind was easterly and surface temperature 57·6°F. Evadne, Podon, Sagitta, and Auricularia were all abundant in the tow-net gathering. About this time I secured several specimens of the larval form of a species of Nemertine, which I have been unable to identify so far. I have some of these specimens preserved, and have also studied their internal anatomy by means of serial sections.

The interesting Siphonophore Muggiœa atlantica continued to be very abundant in surface-net gatherings during the month.

October. On the 1st, surface temperature at 11.30 a.m. was 57·9°F. The following forms were noticed in the gathering made at that time: Sagitta, Evadne, Podon, Muggiœa, females of Corycæus anglicus with ova attached, and Calanus finmarchius. A few small Monstrilla rigida were also detected. From that date till the 8th the tides were very strong, and my attention

was directed to shore hunting in various parts of the harbour. On the 10th the surface temperature was 54·6°F. The most interesting forms observed in the gathering were Muggiœa atlantica and various species of spinid larvæ. At this time when Corycæus anglicus began to abound in the surface net, I noticed that in numerous instances these individuals were covered with the frustules of a species of diatom. These diatoms did not appear to hinder in any way the progress of the individuals through the water. On the 15th the surface temperature was 52·6 F. The only forms in the tow-net on this occasion were some very large examples of Calanus finmarchius and Sagitta. During the remaining portion of this month the tides were again strong, but the wind being nearly all that time from the north, made surface gatherings very poor.

November. On the 2nd of this month the wind was from the south-west, and surface temperature in the morning 52·3°F. Euterpe gracilis occurred in the gathering in great profusion. In several instances the females of this species had ova attached. On the 10th the surface temperature of the sea was 52° F. A few specimens of Podon were observed, and Corycæus anglicus occurred in profusion in the gathering. All the females of the last named species were carrying ova.

During this month the interesting Siphonophore Muggiœa atlantica steadily decreased in numbers in the surface net. On the 15th the surface temperature was 52·9 F at 2·20 p.m. when the net was worked, the wind for the two previous days having been from the south to south-west. In this gathering I noticed several specimens of Ceratium tripos and a small number of Noctiluca miliaris. It will be noticed that this last named species of Infusorian, for some reason which I am unable to explain, has been very scarce this year in the sea near Falmouth.

On the 21st, surface temperature being 51·9° F, the only specimens of interest on that day were a fair quantity of Tintinnus ampulla in the surface net.

On the 23rd, the wind being south-east and surface temperature 51·3°F, a very few specimens of Muggiæa atlantica were secured in the tow-net. On the 26th only two specimens of

this Siphonophore were secured. Since that date this interesting species has disappeared from surface-net gatherings. It is worthy of note that Muggiœa atlantica has always been present in greater or less abundance in surface-net gatherings from August 8th to November 26th in the sea near Falmouth. I may here also direct attention to the fact that Evadne and Podon also vanished from surface-net gatherings after the 23rd of that month. On the 30th the surface temperature of the sea was 52° F.

December. Gales of wind from various quarters prevented my getting afloat till the 6th of this month. On that day the surface temperature of the sea was 50° F. In my surface-net gathering I found Corycæus anglicus fairly abundant, six females of that species having ova attached. In the same gathering a few small specimens of Oithonia spinifrons were noticed, and also six small Sagitta. On the 10th the surface temperature was 49° F, and the tide high-water when the net was worked. In this gathering Eurtepe gracilis were noticed in abundance. In the same gathering were large numbers of Corycæus anglicus with quantities of a species of diatom attached to various parts of the cuticle. At this time I also noticed numerous specimens of Clausia elongata covered with diatoms.

On the 16th of this month, last year, I captured while working my tow-net in the harbour a single specimen of Nyctiphanes couchii. Since that date up to the present time I have not captured another of that species.

On the 14th of the current month it was high water at noon, the wind having been blowing steadily from the westward for some days previously. On that morning I made a surface-net trip, and worked my net across the tide about two miles south-east of the Manacle rocks. The surface temperature at this point at 12·30 being 51·9° F. On making a hurried examination in the boat of the contents of the tow-net, I was pleased to observe several specimens of Nyctiphanes couchii. The wind had been steadily increasing in force ever since I had left Falmouth, and when the first gathering had been made the tide had begun to ebb. As a natural consequence there was a

good sea running, and we had to abandon our position for a more sheltered locality inside the Manacle rocks. Had the weather been more favourable, I would gladly have remained in this locality for some hours, and have worked the net at various depths, with a view to discover whether or not this species of crustacean abounded in the locality. After working the surface-net in several places in the bay, I returned with my captures to my hut. In the collection made at the greatest distance from land I found the following specimens: Sagitta, Corycæus anglicus, Calanus finmarchius, all very abundant; a few specimens of each of the following: Cyphonantes, Centropages typicus, and Oithonia spinifrons; six specimens of Nyctiphanes couchii, 7 to 9 m.m. in length; and two specimens of a species of Hyperia, which so far I have failed to identify. In the remaining gatherings I did not find any specimens of interest.

On the 27th, after easterly gales, Oithonia spinifrons was very abundant in the tow-net gatherings, and although the weather was very cold at the time, surface temperature being 46·3°F, I found in the gathering a few Thaumentias hemispherica. These specimens varied considerably in size, measuring from 5-2 m.m. in diameter.

On the morning of the 28th the surface temperature was 46·9°F. The most interesting form secured was a single Solen measuring 1 m.m. in length. I have made some drawings of this mollusk, and have it living in a healthy condition in my hut in a small pan of sea water. In this gathering I also observed several specimens of Corycæus anglicus with quantities of diatoms attached to various parts of the cuticle.

From that day to the end of the year the weather was very unsettled, and I was unable to venture out surface netting.

It is my custom to arrive at the locality where I intend to work my surface-net at 10 a.m. At this hour the surface temperature of the sea is taken, and the tow-net worked just under the surface of the sea, and kept in that position for twenty minutes, when it is hauled on board, and the contents carefully emptied into a large collecting bottle, and examined on my return to my hut.

II. Additions to the Fauna.

Before recording the interesting marine forms captured since my last report, I should like to direct attention to a fact which, so far as I know, has not been recorded.

Before the memorable blizzard of March, 1891, the main channel of Falmouth harbour was throughout its course almost lined with Ascidians; the majority of the specimens being Ascidia mentula and A. tuberculata. On the 6th of February of that year, I spent the day dredging in the main channel of the harbour. It is recorded in my note book that these Ascidians occurred in such abundance that the dredge had to be hauled more frequently than usual, and when it reached the surface, the bag was found almost filled with these animals. Naturally these Ascidians afforded a fine hold for Comatula and various species of Hydroids and Polyzoa.

On the 5th of May following I spent the day dredging in the same locality, and, curious to relate, the Ascidians and Comatula had vanished from the ground, and for a full year few specimens were found. Since then, to the close of my report, I have spent many days dredging in various parts of the harbour, and have never secured more than a few isolated specimens of Ascidia mentula and A. tuberculata.—Vermes.

Although fresh-water rotifers were the earliest, or one of the first living forms to which the microscope was directed shortly after its invention, it is curious to notice that in the various reports published by previous Cornish naturalists, I have been unable to discover a single record of either a fresh or salt water rotifer.

There is an exceedingly interesting species of parasitic rotifer, Seizon annulatus, to be found in small numbers attached to various parts of the cuticle of Nebalia bipes. This Phyllopod occurs in abundance in certain localities in Falmouth harbour.

During the past autumn I have found in the reservoir near Penryn, Melicerta ringens in large quantities, and small numbers of Limnias ceratophylli.

In a marsh pool this autumn near Chyoon granite quarry, I secured a single colony of that interesting social rotifer Conochilus volvox.

MOLLUSCA.

During the morning of the 10th of August, 1891, the steam dredger "Briton" which for some time previously had been moored over a large bed of Zostera, was beached at high water to have her sides scraped and cleaned. As soon as the tide had left her dry, I went and examined her sides for interesting specimens. Without any difficulty I found eight specimens of Dendronotus arborescens, the largest measuring 28 m.m. in length when crawling. This mollusk appears to be very rare in the south-west portion of England, since Dr. Cocks does not record its capture in any of his lists, and my friend Mr. Garstang (5) has only captured two specimens of this nudibranch during his residence in Plymouth.

On the 23rd of September of the same year, on hauling in my dredge off St. Mawes castle from the deep water, I found therein a large stone covered with various species of Hydroids and Polyzoa. When I returned to my hut, I placed this stone in a large glass vessel of sea water, and shortly after was pleased to see several specimens Æolis landsburgii swimming in an inverted position just under the surface of the water. This species also appears new to the district. I had intended measuring and making additional observations on these mollusks, but as the day was drawing to a close, I had to postpone my investigations till the following day. Before closing my hut, I placed the jar containing these nudibranchs in large tray, from whence an overflow pipe conveys the waste water from my aquaria into the sea. These mollusks must be very active, for on the following morning they were all gone, having escaped I imagine by the waste pipe into the sea. Since that date I have not seen any more specimens of this nudibranch.

On further examination of the material brought to my hut on that day, I found on an old oyster valve, a single specimen of Polycera quadrilineata, measuring only 3 m.m. in length. On the 3rd of October following, I secured under the Eastern breakwater another specimen of the same species, measuring 16 m.m. in length, and on the 18th of January of the current year, I secured another under a stone at low water in St. Just creek. Dr. Cocks records the capture of two specimens of this species by Dr. Vigurs in Gerrans bay. In connection with this

nudibranch, I think it will be necessary to introduce here the following facts. There are usually moored about 100 yards north of the Foundry seven coal hulks. The sea-bottom in this region is composed mostly of mud, from which a fine growth of Zostera springs. Indeed the growth is so luxuriant, that one experiences the greatest difficulty in dredging anything from this locality. During extreme low water at spring tides, the keels of the vessels are within a few feet of the sea bottom, but never actually rest thereon. About every twelve months or so, the owners find it necessary to beach, scrape, and finally tar these hulks, in order to keep them in good order. It is my custom to watch when these hulks are beached, for one finds various species of Ascidians, Hydroids, and Polyzoa on their sides, and often interesting and at times rare specimens are secured by these means. In addition to examining these hulks when beached, on calm mornings once a fortnight or more frequently, I make an examination of the sides of these vessels when at their moorings, to see if any new forms have appeared since I last examined them.

On the 9th of October of the present year, I found on one coal hulk while at her moorings, quantities of Polycera quadrilineata. Indeed, these mollusks were so numerous on the sides of this vessel, about three inches below the water-line, that without shifting my boat, I collected two dozen specimens. On the 12th of December, 1891, I found near Trefusis point a single specimen of Polycera ocellata 6 m.m. in length. On the 25th of January, near the same place, I found one Doris coccinea, and on the 28th of March following, another specimen of that species near the same locality.

On the 31st of the same month, during a ramble round Helford at low water, I found Æolis papillosa literally swarming on the bar. In places these mollusks were so numerous that I had to pick my way in order to avoid crushing them. Goniodoris nodosa was also abundant under the clumps of Fuci left exposed by the tide. Some large specimens of Doris tuberculata were also noticed in the same locality.

On the 12th of February I captured while dredging, one Ægirus punctillucens 1 c.m. in length.

On the 28th of March, during spring tide, I found under some stones exposed at extreme low water at Trefusis point, four beautiful specimens of Aucula cristata. On the following day I secured several more specimens of the same species close to the same place. Four of these mollusks when crawling in a glass dish, measured respectively 11, 10, 9, and 11 m.m. in length.

Mr. Garstang found a single specimen of Æolis picta on a floating raft belonging to the Dock company on the 27th of May. Just as I was closing this report, I found another specimen of this mollusk on a moored coal hulk. This nudibranch is new to the district and is rare.

On the 24th of June I dredged a single individual of Trioper claviger, 21 m.m. in length.

The beautiful nudibranch Antiopa cristata has hitherto been considered a rare specimen in Cornwall. Dr. Cocks in his various reports has recorded from time to time the capture of single specimens of this mollusk. Mr. Garstang (5) in his report records the capture of four specimens only of this species. On the morning of the 6th of October I made one of my periodical examinations of the sides of the coal hulks. As there was but little wind, I was able to view from my boat the sides of these vessels for a considerable depth. I was delighted to find that in several instances there were several specimens of A. cristata crawling on the sides of the hulks. I got a dozen at once, and in a few days later, I had no difficulty in securing three dozen and sending them to Mr. Garstang. A short time later, this species literally swarmed on the sides of the hulks, and presented during calm weather a beautiful sight to the observer. Three specimens of this mollusk taken at random measured 49, 32, and 34 m.m. respectively in length. On one occasion while collecting specimens of A. cristata to send to Plymouth, I noticed a good number of what I imagined to be Thecacera pennigera a few feet under water, crawling up the side of one of the hulks. As these were too far down for me to fish up with a landing net, I took no further trouble in the matter, and naturally imagined that in a few days they would crawl higher up, and then I could easily secure some. Unfortunately the next few days were very stormy and cold, and the

coal hulk on which I observed these specimens was taken into the roadstead to supply a steamer with coal. When the weather moderated and I was again able to visit this hulk in my boat, I was sorry to find that all the supposed specimens of Thecacera had vanished, and only a few Antiopa remained in places where they had been so very abundant. On the 16th of October I secured from the hulks the following nudibranchs: large quantities of Æolis coronata, several Æ. alba, one specimen of Æolis olivacea, and one Æ. farrani.

On the next calm day I went and examined all the moored buoys in the harbour to see if I could find any nudibranchs on them. From the Vilt buoy I secured a single Æolis coronata, the rest of the buoys not having any nudibranchs on them.

On the 5th of December, while collecting at low water spring tides on the southern shore of Pendennis point, I found under a stone one Goniodoris castanea. Dr. Cocks records this species as not uncommon. A few days later I went and examined the sides of the coal hulks, and was pleased to find on them immense quantities of this mollusk. In the majority of instances the nudibranchs had congregated amid-ships, and being mostly of a rich dark red colour, were hardly distinguishable from that Tunicate on which they were feeding. I sent a large number of the mollusks to Mr. Garstang, and with them some specimens of the Tunicate for identification. A few days later Mr. Garstang informed me that the Tunicate was probably Leptoclinum gelatinosum. These mollusks had in many cases taken up their abode on the vessels sides about three inches under water-line, and had deposited numerous coils of spawn in this region. On the 12th of that month a quantity of coal was removed from one of the hulks to supply a steamer, which was taken along side. This had the effect of raising the hulk about twelve inches out of the water, and as a natural consequence the mollusks were in numerous instances left some distance from the water. I naturally imagined that the mollusks would possess sufficient intelligence to find their way lower down, but this did not seem to be so, for I marked some specimens, and in two days they were all dead, having died I imagine for want of sea water. Mr. Garstang, *loc. cit.* records the capture of several specimens of this nudibranch at Plymouth.

On the 17th, one of the men employed by the Dock company, brought me two large specimens of Pleurobranchus membranaceus, the largest measuring two and three quarter inches in length. These mollusks were found exposed at low water on some stones which form a ground work for the Western breakwater. Curiously enough, Mr. J. B. Tilly while standing at the extremity of the Eastern breakwater two days previously, observed a single individual of this mollusk being swept past by the flowing tide. Many years ago he informs me, he captured a single specimen of this mollusk, and submitted it to the inspection of the late Miss Vigurs, who immediately identified it. Dr. Cocks records this mollusk as rare at Gylling-Vase, Helford river, not uncommon. Just as I was closing my last report I dredged a single Pleurobranchus near the Vilt buoy. The following morning I throughly hunted over the tidal docks below high water mark for individuals of this species. Fortunately there was a fair tide, and almost a complete calm, and so I was able to see for a considerable distance beyond low water limit. Along the inner edge of the Eastern breakwater on the balks of timber forming that structure, were quantities of these mollusks left by the tide. At low water in this locality, the sea bottom was fairly sprinkled with specimens of that species, most of which were industriously engaged in depositing their ova. On returning later to my moorings, I noticed this mollusk almost as abundant in that locality as elsewhere; in fact, I observed some coils of their spawn close to the ladder in front of my hut. On the following morning I made an examination of the shore along Trefusis point to see if individuals of this mollusk were also there, but I was unable to find a single specimen there or elsewhere in the outer harbour.

On the 24th of July of the current year, Mr. C. Phillips, of Penryn, very kindly gave me some capsules, each of which contained several young Cephalopods in a living condition. These capsules were obtained from some fishermen, and were doubtless dragged from their position in the sand by the rope attached to the outer edge of the pilchard nets. An individual capsule measured 3 c.m. in length and 1 c.m. in greater diameter. On dissecting a specimen from the gelatinous envelope, and freeing it from its chorion, circulation was plainly

visible in every instance when viewed under the microscope. The weather at the time was very hot, and the temperature inside my hut, in spite of all my efforts, frequently registered 80° F. As a natural consequence quantities of the specimens in my aquaria, died, and with them these Cephalopods. So far as I am able to determine these capsules were deposited by Sepiola atlantica.

On several occasions since my last report, I have found specimens of this mollusk left on the shore by the retreating tide. At Plymouth this Cephalopod is secured in abundance. Curiously enough, Sepiola atlantica is not mentioned by Dr. Cocks in any of his reports, although S. rondeletii is recorded. That last named species I have never yet met with. Sepiola atlantica is abundant in the summer time at Helford, Mullion cove, and also in Watergate bay near Newquay.

Hydroids.

On the 9th of August of this year, the weather not appearing very favorable for a long collecting trip, I spent the morning collecting in the tidal harbour. While drifting in my praam that morning, over some shallow ground close to No. 1 dry dock, waiting for the tide to fall, I noticed swimming in the water a most beautiful gonozooid. On placing it in a collecting bottle and studying its movements for a short time, I at once saw that the specimen had come from no great distance, and when the tide had sufficiently receeded, I carefully examined the under surfaces of the stones in that locality. Without much difficulty I secured a dozen specimens. On the 7th of September following, the tide being sufficiently low, I collected on the same ground upwards of thirty more individuals, and sent some of them to Mr. Garstang at Plymouth. These specimens seem to be confined to a small patch of ground about four yards in diameter, and only exposed during good spring tides. As there is a full historical account of this gonozooid in Hinks' British Hydroid Zoophites it is needless for me to repeat what is already published in that monograph. After having made some camera drawings of these individuals, I placed them in a glass jar with a current of sea water continually passing through. Within a few days a great number of them died, for I was at a loss to discover what to feed these animals on. I then emptied

the contents of a jar containing a tow-net gathering in the vessel containing the gonozooids, and soon observed that they eagerly seized the copepods. By these means I managed to keep them in a healthy condition, and under constant observation till the 15th of October following. During this long time the only important changes observed was a shrinking of the walls of the nectocalyx, and a thickening of the manubrium. Cold weather setting in at this time killed my specimens and stopped my observations. It is curious to note that in spite of all my attempts, I was unable to find attached to the stones where the gonozooids occurred a single specimen of Cladonema radiatum the adult animal of this larval form, which I feel sure must have occurred in some abundance near that locality.

Mammalia.

On Sunday afternoon the 11th of October, 1891, a fine specimen of Delphinus delphis, about six feet long, was washed ashore in a dying condition near the Falmouth hotel. The unfortunate quadruped as it lay stranded on the shore soon attracted attention, and in a short time was surrounded by a small crowd, who attacking it with knives and sticks soon reduced an interesting specimen to a nearly shapeless mass. My friend, Mr. J. B. Tilly, who happened to pass the spot shortly after the occurrence, picked up a single fœtus, which he kindly gave to me on the following morning. On measuring this fœtus I found it 13·8 c.m. in length and 3 c.m. in great diameter. On further examination I found it had been subjected to the roughest treatment. The brain was completely gone, the hyoid and sternum considerably damaged. In spite however of these drawbacks, I was able to make a fair dissection of this fœtus, and to make out some points of extreme interest to me.

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ON THE ORIGIN AND DEVELOPMENT OF ORE DEPOSITS IN THE WEST OF ENGLAND.

BY J. H. COLLINS, F.G.S.

CHAP. III.—ROCK CHANGE AS CONCERNED IN THE FORMATION OF ORE DEPOSITS.*

SEC. 9.—*Surface tension and electricity.*

The effects of surface tension in assisting the underground circulation, and, aided by outwardly impelled currents, in making it universal, have already been considered. Its influence as a depositing agent has also been touched upon—we have now to consider it a little more in detail.

That the actual circulation through fissures will be greatly affected by the size of such fissures is obvious, for very narrow openings will be liable to speedy closure from the deposition of suspended matters, and very wide ones will favour deposition owing to the check of the current, while those of intermediate size will often be kept open by its flow. But in very narrow openings the chemical precipitation will often be very different, owing to the existence of what is known as capillarity, due to surface tension. Mr. R. Hunt, while not doubting the existence and potency of electric currents in veins, yet considered that surface tension was often the immediately effective agent in the formation of ore deposits; and M. Becquerel was of the same opinion.†

The mechanical effects of surface tension under ordinary circumstances are marked when considerable masses of matter are concerned. But as the masses are reduced, the acting surfaces are not reduced in equal proportion, so that finally phenomena which are apparently inconsistent with the action of gravity, and which are really independent of it, become evident. Thus a very small quantity of water when poured out on a flat surface forms itself into a sphere under the influence of

* Continued from the *Journal R.I.C.*, No. 38, p. 184.

† See "a contribution to the history of Mineral Veins," *Trans. Roy. Geol. Soc. Corn.*, IX, 23.

this surface tension, while a larger quantity spreads itself out under the influence of gravity until it appears to be a perfect plane. The gravity is acting all the time, but in the case of the small mass with the comparatively large surface the surface tension to all appearance overcomes the action of gravity.

A closely related case is that of liquids in communicating vessels, or in two fissures connected by a transeverse fissure, when under ordinary circumstances the water will stand at the same level in both. If, however, one of the vessels or fissures is *very* narrow, say $\frac{1}{100}$th of an inch or less, the liquid will stand very notably higher in this than in the wider one, thus apparently setting the force of gravity at defiance; so that, given sufficiently small or narrow apertures, the tension becomes so great that solutions have power to penetrate porous substances against strong positive steam or air pressures, equal to many pounds on the square inch, as shown by Daubrée and others.

Such are what may be called the mechanical effects of surface tension ; there are equally remarkable chemical effects. Many decompositions are effected, and many precipitations are induced by it, as was long ago demonstrated by Becquerel, Hunt, and others.* Among natural examples of the operations of this force, I may refer to the thin plates of native copper found in the joints of elvan and killas at the Gwennap Mines and many other places, and the arboreal markings of manganese which are so common in the finer joints of rocks almost everywhere.†

One of the effects of this penetration of solutions through narrow fissures, and of the deposition of foreign matter within them must be to widen them, so that there is a constant tendency for potential structural planes to be converted into actual, and for actual divisional planes to become wider. Of course this

* See experiments of Becquerel quoted by Hunt, and also his own, in his "Contribution, &c.," *Trans. R.G.S.C.*, IX, 23.

† It has been shown by the experiments of Dr. Hofmann and Mr. Witt that a certain portion of the salts dissolved in water are separated by passing through the filter-beds of the London Water Companies. Mr. R. Hunt, in his Economic Geology of Devon and Cornwall (*Bath and West of England Agric. Journ.*, XVI, 1868) quotes this, and also refers to certain experiments of Spencer, Normanby, and Graham; and adds "The papers referred to clearly indicate the operation of a force which is most active in all the works of nature."

widening of fissures and successive deposition can only go on (*a*) when the rock is shrinking, or (*b*) where there is room for the rock's expansion in some other direction, or (*c*) when some constituent is progressively dissolved and carried off by the circulating fluid, or (*d*) where colloid is being transformed into crystallized matter. As a matter of fact, evidences of all these modes of action are exceedingly common in all ancient rock masses.

It will be seen, therefore, that the very same portions of fluid may at one time circulate through open fissures of considerable dimensions (canalicular circulation), at another through very narrow or capillary channels (capillary circulation), at still another through the potential divisional planes, or between the separate rock constituents (interstitiary circulation); the results being different in each case, although there may be no absolute line of demarcation between one form of this circulation and the others.

The important changes in rocks, known as kaolinization, uralization, serpentinization, schillerization, alunation, &c., and mineralization generally, seem to be due directly and mainly to the interstitiary circulation—all the modifications of force just referred to taking part in the action in turn or together; some of the combined results of these complex operations must be dealt with in the next section.

Electricity. The phenomena of the earth's magnetism were referred to the action of electric currents circulating around it by Ampère more than 60 years ago. In 1832 Mr. Robert Were Fox, who had been experimenting for several years in the copper and lead mines of Cornwall, Devon, and Derbyshire, wrote that this hypothesis seemed to him "to derive strong confirmation from the stratification of rocks, the arrangement of metallic and other veins, the high temperature which, in a greater or less degree prevails under the surface of the earth, and its rotation on its axis.... I was consequently led to suspect the existence of free electricity in metallic veins, and I was not disappointed."* The experiments he had undertaken in 1829 at Wheal Jewel and other mines, and reported in a paper read to the Royal Society

* *Proc. Roy. Soc.*, III, 1832, pp. 123-125. *Phil. Mag.*, I, 1832, pp. 311-314.

in 1830, were continued at intervals by himself and his assistants* until the year 1842, in the following mines among others, Wheal Rose (lead), Wheal Friendship (copper), Wheal Betsy (copper), Pennance (lead), Lagylass (lead), Frongoch (lead), South Mold (lead), Miller (lead),—the last our in Flintshire,—Coldberry and Skeers (lead), Durham, &c. At Pennance Mine, near Falmouth, in 1842, he found the natural currents were sufficiently strong to magnetise iron, decompose iodide of potassium, force sulphate of copper through clay in a U tube, change yellow copper ore to gray ore and oxide of iron, and deposit copper on an electrotype plate. In these experiments the deflection of the needles were observed to continue steadily in the same direction for eight months, from the south vein towards the north, even when the mine was full of water.†

By the continous action of a weak voltaic current, Mr. Fox produced a little later a well-defined lamination structure in a mass of well-kneaded clay placed between two metallic plates, one of copper, the other of zinc, the plates being connected by a wire, and electrically excited by a solution of common salt.‡

He also produced in the clay by this method a veritable series of mineral veins, containing veinlets and pockets of red oxide and green carbonate of copper, and brown oxide of iron, and also a distinct vein of oxide of zinc. Some of these metalliferous deposits were "so hard and firm as to admit of being taken out of the clay in plates the size of a shilling.

*One of these was Mr. W. Jory Henwood, F.R.S., the President of this Institution in the year 1871. Mr. Henwood in subsequent independent experiments came to conclusions differing considerably from those of Mr. Fox, but his experiments were vitiated by a disregard of some essential precautions, as Mr. Fox did not fail to point out.

†These experiments on the electric currents in metalliferous veins were afterwards repeated by Prof. Reich of Freiberg, at the famous Himmelfahrt Mine, and confirmed in all essentials, although his interpretation of the results led him to attribute the phenomena altogether to the hydrothermal action within the veins, and not at all to the general earth-currents, which were considered as largely effective by Mr. Fox.

‡These experiments on the production of schistosity by electrical means were afterwards repeated by Mr. Robert Hunt, with pretty similar results (See *Mem. Geol. Survey*, I, 433, 1846.) Mr. Henwood remarks (*Trans. Roy. Geol. Soc., Corn.*, v) that he and Mr. Sturgeon had failed in the experiment and suggests that the clay was not well-kneaded. But Mr. Fox was far too careful an experimenter to be so misled.

Mr. Fox's observations and experiments were fully described in the scientific journals of the day, and attracted a great deal of attention among all students of mineral phenomena, since they assisted greatly in upsetting the Huttonian hypothesis that such veins were igneous injections.*

As the part played by electric currents in the formation of ore deposits has not received very much attention now for many years, it may be well to give here a short recapitulation of a very important paper which Mr. Fox prepared in 1836.†

1. That admitting the origin of mineral veins to have been derived from fissures in the earth, there is reason to believe that the latter may have been produced by different causes, and at various intervals; also that many of them have been enlarged from time to time.

2. That the accumulation of mineral deposits in such fissures has been likewise progressive; and that the evidences afforded by the resemblance of the vein stones to the several enclosing rocks, and the arrangements and subdivisions of the contents of the veins, are decidedly in favour of both these conclusions; independently of other arguments, based on mechanical principles.

3. That the phenomena of veins seem to indicate that many ot the fissures penetrated to a great depth, and into regions of a very high temperature; and that, consequently, the water which they contained must have circulated upwards and downwards with greater or less rapidity.

4. That since the solvent power of water seems to increase in some ratio to the augmention of its temperature, it is obvious that it would tend to dissolve some substances at a great depth, which it would deposit, more or less, in the course of its ascent through cooler portions of water; and also in consequence of its partial evaporation on reaching the surface.

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* For a fairly complete account of Mr. Fox's scientific work with references to his published papers, see "A Catalogue of the Works of Robert Were Fox, F.R.S., with Notes and Extracts" by J. H. Collins, F.G.S., Truro, Lake & Lake, 1878, where will be found plates illustrating the above-described experiment with others bearing on the origin of metalliferous veins.

†It appeared in the *Report Roy. Corn. Pol. Soc.* for that year, and was subsequently reprinted in a separate form, but is now very scarce.

5. That a part of the earthy contents of veins, and more especially silica or quartz, was apparently accumulated in this manner, and usually combined, more or less, with matter otherwise deposited.

6. That rocks, clay, &c., containing different saline solutions and metalliferous substances, in contact with water charged in many instances with other salts, were calculated to produce electrical action; and this action was probably much increased by the circulation of the water, and differences of temperature; but more particularly by the existence of compressed and heated water, metallic bodies, &c., at or near the bottom of the fissures.

7. That since the water in the fissures containing metallic or earthy salts was a conductor of electricity, especially when heated, and in a very superior degree to the rocks themselves, it is evident that in conformity with the laws of electro-magnetism, the currents of (positive) electricity would, if not otherwise controlled, pass towards the west, through such fissures as were most nearly at right angles to the magnetic meridian at the time.

8. That the more soluble metallic and earthy salts may have been decomposed by the agency of such electric currents, and the bases been thereby determined in most instances towards the electro-negative pole or rock; that tin, however, under these circumstances, is only partly deposited at the electro-negative and partly at the electric-positive pole, in the state of a peroxide; and that these properties of this metal seem to bear on its positions in the lodes with regard to copper, being sometimes found with it and sometimes distinctly separated from it.

9. That the position of one rock with respect to another or to a series of other rocks may, as well as their relative saline or metallic contents, temperature, &c., have had a decided influence on the deposition of minerals on them by electrical agency, so that a given rock may have been *electro-positive* in one situation, and *electro-negative* in another, in regard to other neighbouring rocks, as this is quite consistent with voltaic phenomena.

10. That the evolution of sulphuretted hydrogen, and the tendency of some metals, when in solution, to absorb oxygen and become insoluble, may in some instances have interfered with the regular arrangement of the metals, such as electricity would

have effected; and that hence, many anomalies may have arisen, especially in relation to tin.

11. That the electrical re-action of the different metalliferous bodies, and of masses of ore on each other after their deposition in the fissures, may have corrected such anomalies in some instances, and that they may have given rise to them in others, by changing the direction of the electric currents and modifying the relative positions of the deposits; and that the pseudomorphous crystals of various descriptions, as well as other phenomena observable in mines, fully prove that some such secondary action must have taken place.

12. That cross-veins may have been filled mechanically, or by the deposition of silica from a state of solution, or by both these means; and that the striated and radiated structure of the quartz, may be owing to the tendency of electricity, under ordinary circumstances to pass transversely rather than longitudinally through north and south veins.

13. That assuming the proofs of the progressive opening and filling of lodes and cross-veins to be admitted, it seems to follow that many intersections may have been caused by the more ready accumulation of clay and other mechanical matter, and even of silica from its solution, than of the more slowly-formed metalliferous or crystalline deposits.

14. That the frequent occurrence of a mass of ore in that part of a lode which is intersected by a cross-vein; and also of small branches of ore, from a dislocated part of a lode on one side of a cross-vein without there being corresponding veins near the other part of the lode on the opposite side of the cross-vein, afford strong evidence of the deposition of the ore in such cases after the intersection took place, and that it was accumulated in the E.W. vein, rather than the N.S. one, by the influence of electro-magnetism.

15. That the small veins of copper and tin ore which are often found in cross-veins between the dislocated parts of lodes, and the frequent occurrence of more considerable, and yet for the most part very limited, quantities of these ores in the former in the immediate vicinity of intersections, are additional arguments in favour of the operations of the same definite agency.

16. That the secondary fissures resulting from the cracking off of larger or smaller masses of the hanging sides of veins may have been partly filled, in many instances, by the electric action of different portions of ore on each other; and that secondary lodes may have been formed at right angles to parallel E.W. lodes, in consequence of the reciprocal action of the latter.

17. That many other phenomena of mineral veins, including those of a mechanical character, such as the occurrence of "horses," "heaves," &c., appear to be capable of satisfactory explanation on the principles which have been (here) laid down.*

Mr. Henwood, who at first did not agree with Mr. Fox's conclusions, and who, to the last day of his life, declined to theorise on his facts, remarks that Mr. Fox had only detected electric currents in connection with copper and lead lodes, and not in tin lodes, veinstones, or rocks. Von Strombech, too, failed to get current indication at St. Goar on the Rhine, 1833. In 1838, Mr. Pattison reported certain somewhat doubtful results which he had obtained in the sandstones and limestones of Alston Moor,† and in 1839 Reich got good results between veinstones and ores, while Henwood got distinct evidence of current by connecting oxide of tin and iron pyrites at the 106 fathom level in Rosewall Hill Mine, and in all cases, when he used a delicate galvanometer (Watkins and Hill's) he got results even with rocks.

These various experiments and results point perhaps to a more general cause than the local electrical currents passing along the veins, from rich part to rich part, or from one ore to another, which was the only cause admitted by Reich, though they do not seem to be very closely connected with Amperè's general earth currents occasioned by the rotation of the globe, as held by Fox. The local currents are, indeed, effective in distributing, or in concentrating the ores in the rich parts, but there is certainly more than this to be seen. It is hardly possible to conceive that that two rocks, of dissimilar nature, or even only under dissimilar conditions, can exist side by side, both subject to chemical

* *Trans. Roy. Geol. Soc. Cornwall*, v, 1843.

† *Brit. Assoc. Report* for 1838.

changes, without being in somewhat different electrical states. This being so, there must be constantly in action direct currents from one to the other, *across* the run of their junctions. Some of the effects of such transverse continuous currents are illustrated by Mr. Fox's experiment with the clay enclosed between metal plates already alluded to. Does not this mode of viewing the subject explain in some degree the frequent occurrence of rich parts in or near contact zones, and the reasonableness of the miner's universal belief in the beneficial effect of a juxtaposition of dissimilar rocks in a mining district? It is in fact the great constantly acting deposition battery. Of course it cannot make metalliferous deposits if the region contains no soluble metal, any more than the battery of the electro-plates can go on depositing after its solutions are exhausted; but given suitable solutions, and every mineralized region supplies such; suitable places for deposit, and these we get in disturbed and fissured country; and a sufficient battery, which is supplied by the juxtaposition of dissimilar rocks; and we have all the favourable elements for the formation of rich parts. It seems to me that, from the electrical point of view more than any other, it may be possible to study the mutual relations of ore deposits and country rock with advantage.

An interesting illustration of what is apparently the directive force of electricity is afforded by another phenomenon. It is a matter of the commonest observation that certain minerals are often deposited in joints of definite direction, and not in others having different directions, or on certain planes of a crystal in a vein, and not on other planes differently oriented. Thus, at the Treskerby Quarry, in so-called "primary granite," schorl and chlorite are deposited in E.W. joints, but not in those running N.S.* Similarly at Carn Marth, joints running 25°S of W. have amethyst, fluor, and chlorite, while those running 10° W. of N. carry schorl and oxide of iron; and in the Trelubbus Quarry joints 20° S. of W. have chlorite, chalcopyrite, mispickel, and blende, while the approximate N.S. joints contain schorl and oxide of iron as at Carn Marth.† The parallelism of such phenomena

* Notes of Excursions, *Rep. M.A.*, 1864.

† Ibid.

on a small scale with the larger observed association of tin with E.W. veins, and of iron and the rarer metals, such as uranium, cobalt, nickel, &c. with N.S. veins, is obvious, and the causes are probably similar if not identical in character. These electrical experiments of Fox and others, though arising from Mr. Fox's acquaintance with Amperè's hypothesis, have not shown any particular connexion of the veins and rocks and their local currents with Amperè's general currents;* and Mr. Fox's first idea, that the stratification of rocks, &c., were connected with or due to such general currents was soon given up by him, as well as by others. Although he was able to produce schistosity in well-kneaded clay by electrical means, yet except perhaps for such local phenomena as the sheeting already mentioned and the local laminations of clays, we must look to mechanical causes for large scale stratification, lamination, and schistosity. And further, although given such longitudinal structure, and its accompanying longitudinal jointing, electricity might convert some of these joints into lodes, yet the proof of an absolute fissure in a great majority of cases was soon admitted by him.

Another of Mr. Fox's anticipations has also not been realized up to the present. He hoped to discover great bodies of ore by means of their electrical indications; but although the existence of masses of magnetic iron-ore has been ascertained in Sweden, Canada, and the United States, by the somewhat analagous use of his dipping needle, I believe no such practical applications have hitherto been made of the galvanometer, and bearing in mind the difficulties of the problem, it is hard to have hope of ultimate success in this direction.

* It may, however, be remarked that Mr. Henwood's experiments, and his conclusions recorded in 1843 (*Trans. R.G.S.C.*,v.) in no way negative the existence of such general currents, it is merely that the far stronger currents were not eliminated. To detect general currents in the neighbourhood of metalliferous deposits must be as difficult as to ascertain the directive effect of the earth on a magnet in the immediate neighbourhood of masses of magnetite. It may perhaps be granted that the influence of general currents in forming valuable metalliferous deposits is small, perhaps even insignificant except as a start, and this, I believe, was pretty much Mr. Fox's final conclusion. A similar difficulty exists in determining the normal increase of subterranean temperature, since hitherto all observations have been made in places where abnormal conditions exist; yet few will doubt that there is such a normal increase.

The essential difficulty in all such cases is the same, viz.: that small, and even insignificant bodies, if very near, act as energetically on the dipping needle or the galvanometer as large and valuable bodies at a greater distance, and also that, owing to the action being inversely as the square of the distance, it is too feeble in most cases to make itself evident at all, even at very moderate distances.

Mr. Fox's experiments on the influence of electricity on sulphide ores as bearing on the origin of gozzans will be referred to in the next section.

SEC. 10.—*Some specific effects of the underground circulation.*

The physical forces referred to in Sec. 8, acting by means of the circulating waters (Sec. 7) produce certain remarkable and wide-spread changes in the country rocks, as well as on already existing metalliferous deposits. Some of the most important of these will be here dealt with.

Hydration. This is seen in the occasional conversion of masses of hematite into limonite, and of anhydrite into gypsum, the original structure and texture being often perfectly preserved. Micaceous rocks are often found with the mica more or less changed by hydration: in this way Damourite, Margarodite, and some other minerals appear to have been formed. Pure water is able to effect many such changes, but water charged with carbonic acid, as is the case with all natural waters falling through the atmosphere, acts much more thoroughly and rapidly.*

The hydrated micaceous mineral Sericite seems to have been formed by circulating waters; not however by the hydration of pre-existing micas, but as a decomposition and re-composition product of other non-micaceous silicates.

Formation of Gozzan. This is essentially a process of oxidation, accompanied in most instances by hydration. In the West of England, gozzan consists mainly of hydrated peroxide of iron,

* A. Johnstone in experimenting on Muscovite found that pure water had the same effect as water charged with carbonic acid, viz., the mica was simply hydrated; but with biotite, iron and some other components were carried off when carbonated water was used, while it was simply hydrated by pure water. All, however, increased in bulk. *Q. J. G. Soc.*, No. 173, p. 363.

mingled in most cases with more or less of siliceous substance, this latter being frequently in the brittle form of quartz, known as "sugary-spar," or of the highly cavernous form known as "floatstone." Sometimes there is also a whitish or reddish clay present (prian), also partially oxidised masses of pyrites, marcasite, and other sulphides, with in many cases crystals of oxide of tin.

Gozzan is peculiarly characteristic of copper-lodes, as was long ago observed by Pryce, often extending to great depths, and even below the sea-level, as at the United Mines in Gwennap, North Grambler near Redruth (85 fathoms), Fowey Consols (100 fathoms below adit), the Phoenix Mines, Devon Great Consols, and Wheal Friendship. Many of these gozzans contained occasional sprigs of native copper; more frequently considerable quantities of the black and red oxides and blue and green carbonates of copper, together with smaller quantities of the various phosphates, arseniates, uranates, and other rare mineral compounds.

A good gozzan even in Cornwall does not of course necessarily imply the existence of a valuable copper deposit beneath, since it may be merely the result of an oxidation and hydration of ordinary iron pyrites of little or no commercial value; yet so generally is it the case that rich deposits are thus indicated, that no miner would hesitate to follow a really good gozzan, especially if it contained mere traces of copper; on the other hand, no miner would be disposed to place much confidence in any copper lode, unless it had a "good gozzan" in some part of its course.

Iron ore has been obtained, not only from iron lodes proper such as those of Restormel, Pawton, and Brixham, but also from the "backs" of very many copper, lead, and tin lodes: indeed the great Perran lode itself is thought by many to be merely the upper portion of an immense copper lode

Some lode-gozzans have for many years yielded quantities of ochre, either by simple stamping and washing, or, in some instances by merely settling the outflowing waters. It is worthy of note that the ochre thus obtained usually contains some notable proportion of sub-sulphate of iron, indicating clearly its origin

from an alteration of pyritous substance. At Wheal Jane and Virtuous Lady such gozzans may be traced directly down to unaltered pyrites.

The gozzans at Levant, Carn Brea, Dolcoath, and many other mines, have yielded considerable quantities of tin, which occurred for the most part in brilliant dark-coloured and greatly modified crystals. At North Grambler the gozzan was so rich for tin at the 85 fathom level that it was worked for this metal at a tribute of six shillings in the pound.

Blende has been obtained in large quantities at Great Retallack, Duchy Peru, Burrow and Butson, Wheal Busy, and many other mines.

Many gozzans have yielded notable quantities of chloride and other silver ores, as for instance those of North Dolcoath and Herland; while gold has been found in minute particles in a great many instances, though nowhere in paying quantities. Nevertheless it must be admitted that in the west of England gozzans are to be looked upon rather as indicators of underlying deposits of value than as being themselves of economic value.

Although the gozzan occasionally extends far below the permanent water-level of the country, yet in general this is not the case. Ordinarily as soon as this water-level is reached, or very soon after, the ores present (except in the case of tin, which is not known as a true sulphide) are found to be almost exclusively "pyritoids" (sulphides, arsenides, and the like); and this fact, taken in conjunction with the occurrence of partially altered sulphides present in the gozzan, leaves no room for doubt that originally all the oxides of the gozzan—tin and some iron and manganese excepted—have been derived from pre-existing sulphides.

The change of carbonate of iron into peroxide was very plainly observable in the bottom of the Pawton mine near St. Columb in 1874. In this case as in many others, the anhydrous peroxide was formed from the carbonate notwithstanding the enormous quantities of moisture present. I saw the same thing in the Brendon Hills Mine, in Somersetshire, about the same time. In each of these cases, too, it was plainly seen how cellular quartz had been formed by the oxidation and removal of crys-

talline aggregates of chalybite, which had been subsequently permeated by siliceous solutions, and so coated with quartz. A similar oxidation of sulphides and removal or alteration of carbonates has been observed in all mining countries, and to this is due the greater part of the difference between "free-milling" and "refractory" gold and silver ores in the Rocky Mountains.

The production of gozzan seems in most cases to be due to the action of surface-waters percolating through the fissures or their mineral contents. Hence it is, that when once the water-level is reached, or where the lode is so solid as not to admit of any considerable circulation, there is little or no oxidation. When, however, the gozzan extends below the water-level, it is more likely to have been produced by thermal springs since exhausted, and the large quantities of gozzan material spread over the surface in some situations supports this view, and evidences the recent character of the extinction.

The experiments of Fox, Becquerel, and Hunt, show that electrically-excited salt water acts powerfully on chalcopyrite, converting it into erubescite and setting free peroxide of iron. Supposing this process to take place in the depths of the earth in connexion with an upward current, the iron oxide would be deposited at or near the surface as gozzan. In this case, the gozzan would be an indication not of bodies of iron-ore but of chalcopyrite and erubescite, and traces of copper would be more or less abundant in it.* Some further characters of gozzans and of their relations in their underlying mineral deposits, as well as to the surface contours of the regions in which they occur, will be dealt with in the fourth chapter.†

* In this connexion some recent experiments of Mr. W. N. Steernwitz are of interest. He placed crystals of ferrous sulphate in a cold solution of an alkaline silicate. After a time, thin nearly colourless threads began to rise from the crystal through the solution to the surface, where they became oxidised, spread about, and finally were deposited as a brown ferruginous silicate "resembling that of the iron outcrops which indicate ore-veins." When salts of other metals were present, traces of them were found in the ferruginous deposit. (See *School Mines Quarterly*, *U.S.A.*, 12, 181-186.)

†For interesting particulars relating to gozzans, *see* Henwood, *Trans. R.G.S.C.*, v.; Argall, *Rep. M.A.*, 1864 and 1872; Phipson, *Mining Journ.*, 1864; Collins, *Journ. R.I.C.*, 1888.

Kaolinization is a peculiar change to which many aluminous-alkaline silicates are liable, and especially the various forms of felspar. It seems to be effected by the underground circulation, which, decomposing the original silicates, carries off the alkalies, leaving a hydrated silicate of alumina behind, free quartz being at the same time deposited whenever there are cavities. This change is effected gradually, so that in many instances the form of the original felspar is perfectly retained. Few felspars are altogether without indications of, at least, incipient kaolinization; and the china-stone (Petuntzyte) and china-clay rock (Carclazyte) so abundant in the West of England are important results of this change operating on an extensive scale.

It seems likely that, generally speaking, felspathic rocks may have been kaolinized by the action of percolating atmospheric waters charged with carbonic acid, and at ordinary temperatures and pressure; but it is very unlikely that any kaolin of economic importance has been thus produced. Rather, in such instances, the change seems to have been effected by the action of solutions containing fluorine (with sometimes at least chlorine and boron) arising from considerable depths through fissures, as was long ago suggested by Von Buch, Daubrèe, and others. All forms of circulation could aid effectively in this; the canalicular to bring up the active solvent from below, as well as to carry off the dissolved alkalies, and the capillary and interstitial to permeate add change the interior of the rock-substance.

The enormous economic importance of this form of change in the felspathic rocks of the West of England is indicated by the fact that the yearly exports of china-clay and china-stone from the two counties now amount to over 400,000 tons, necessitating the removal of probably 6 million tons of rock and overburden. The softening of aluminous killas near many lodes and the production of prian are direct results of this kaolinization process; while the production of schorl-rock, gilbertite quartz, and capel, are intimately connected with it.*

*For a fuller discussion of this subject, *see* the following works by the present author :—1, "The Hensbarrow Granite District," Truro, 1878. 2, "On Cornish Tin Stones and Tin Capels," Truro, 1883. 3, "On the Nature and Origin of Clays," *Min. Mag.*, 1888.

Serpentinization. This is a change somewhat analagous to the last, to which olivine, and in a less degree most forms of pyroxene and amphibole, as well as some other minerals, are subject. Full and free circulation of the solvent seems to be necessary, and probably also both heat and pressure. I endeavoured to show some years since that "serpentinous change is scarcely less common, though of course much less extensive in the West of England, than kaolinization, and that in some instances the same rock-mass affords evidence of both kinds of change," and after quoting from Dr. Sterry Hunt, I went on to say "The change has probably required a circulation of waters containing magnesian chloride in solution, and aided by heat and pressure; submergence in the waters of the sea to a considerable depth would suffice to give all these conditions."*

Uralization and amphibolization. The changes of augite into uralite, and of uralite and diallage into hornblende are so-called. They are almost as universal in the West of England as kaolinization, although their field of operation is far less extensive. The changes, too, are very analagous, except that there is no evidence of the presence of fluorine, while considerable heat and pressure were probably essential in addition to the circulating solutions. Most of the intrusive "greenstones" and "gabbros" afford evidence of this kind of change.†

Schillerization or the alteration of augite, enstatite, &c., into diallage and bronzite, consists (according to Prof. Judd, who has made a special study of the subject), in the development of minute enclosures in the form of thin plates or delicate rods along one or more sets of parallel planes in the minerals so altered. This development, which is very common in the Lizard district, always seems to take place along definite cleavage planes, but the largest development is not always in the freest cleavages. These plates, rods, &c., are considered by Prof. Judd to be "negative crystals filled with products of decomposition." The development seems to be proportionate to the depth of the rock from surface at the time of the change, and consequently may

**Geological Magazine*, July, 1885, August, 1886, and May, 1887. "The Geological History of the Cornish Serpentinous Rocks."

† See Allport, "Rocks of Land's End District," *Quar. Jour. Geol. Soc.* 1876, pp. 15-29. Phillips, *Quar. Jour. Geol. Soc.*, May, 1876.

be regarded as the result of what I have called capillary circulation, aided by heat and pressure. It is probable that some special solvent is necessary, since schillerization is local and not general, and also because the secondary deposits in the negative crystals seem to be in some instances derived from without. This schillerization is common in many of the Lizard rocks, but I am not aware it has been observed in the mining districts of the West of England. The conversion of orthoclase into murchisonite, as observed near Dawlish, seems to be a combination of kaolinization and schillerization, and the peculiar *chatoyant* lustre of labradorite is, according to Judd, due to a similar development of *ultra*-microscopic plates.*

Alunation. This consists in a decomposition of alkaline aluminous silicates by the aid of sulphuric acid. The acid usually results from the atmospheric oxidation of iron pyrites, as may be seen in the shallower parts of many of our mines, and in some places on the coast, in which case it may be regarded as a form of weathering;† or it may be supplied by volcanic fumeroles, or by thermal springs. Alunation may be seen in operation on many mine-burrows where pyrites occurs associated with aluminous veinstones.‡

Calcification. Where calcareous matter is contained in the rocks, the waters flowing over or issuing from them are always "hard," that is, they contain carbonate of lime in solution. When such waters flow over loose sands or porous strata as met with along the north coast of Cornwall, the interstices become filled with carbonate of lime in a more or less crystalline condition. This may be seen in the calcareous amygdaloids near Port Isaac, on the north coast; in the slates underlying limestones in many

* For a full discussion of schillerization, see Judd, *Quart. Journ. Geol. Soc.* 163, pp. 377, 383, 387, 408; and 165, p. 82.

† See the account of the hot chamber in the author's description of the Perran Iron Lode already referred to.

‡ An interesting example of alunation on a large scale is afforded by the Yorkshire cliffs near Whitby, and by the cliffs of London Clay at Sheppey. Daubreé, in his *Les eaux anciennes*, also refers to an instructive example at Tokay, in Hungary, where certain trachytic tuffs have been converted by the agency of thermal springs containing sulphuric acid into alunite. This material forms extensive fossiliferous beds at the foot of the eruptive masses, while the silica set free has super-silicated the tuffs in question so that they become suitable for millstones.

parts of Devonshire; a similar phenomenon is observable in the Perran and Mithian sands, and especially in the sands near Crantock and St. Enodock. The extensive dunes of blown sand along the north coast contain a large proportion of carbonate of lime in the form of comminuted shells. The rain-water in sinking through the upper layers of the sand dissolves out part of the carbonate of lime, and in favourable circumstances, where there is an underlying stratum of comparatively impermeable ground, this is re-deposited in such a way as to convert the lower layers of the sand into a fairly compact and durable sandstone of great value for (local) building purposes.

On the other hand, the withdrawal of carbonate of lime in solution has frequently altogether removed or extensively changed beds of calcareous rock, as in the case of the coral-bearing shale at Newham alluded to. Here the forms of the corals and even their minute structure are still perfectly distinct, yet the rock now contains a mere trace of lime.* There is no means of knowing where the lime has gone in this instance, but in general the lime must have been removed before the principal lodes of the West of Cornwall were formed for it is an undoubted fact that with a few local exceptions the lodes in this part of the county, where limestones are almost unknown, contain very little calcite as a veinstone.

Silicification. I am not aware of any notable siliceous springs in Cornwall or Devon, but the mine waters analysed have contained on an average nearly two grains of silica per gallon, whether thermal or phreatic. Water containing this comparatively small quantity of silica would still be capable of silicifying shales and sandstones (as at the Haytor Mines), of depositing cross-course spar (as in the numerous cross-courses), of filling cracks in the rock (as seen in the killas of so many places), of indurating sandstones and conglomerates (as at Ladock and the Nare Point), or of forming siliceous bands in the granite or siliceous capels in the killas. The process of kaolinization liberates a considerable proportion of uncombined silica, and this we constantly see in bands traversing the carclazyte, accompanied in some instances by schorl and cassiterite.

*Recent Mineralogical Analyses, by J. H. Collins, *Jour. R.I.C.*, XXIII.

The economic importance of silicification to the miner is in two directions,—the one favourable, the other unfavourable. By its influence in strengthening the walls of fissures, otherwise much weakened by kaolinization and other changes, it is favourable; but when, as in many instances, the ore present is, so to speak, buried in large quantities of hard siliceous capel, the cost of excavation and of subsequent treatment is largely increased, and its effect is decidedly unfavourable.

The cross-courses of the mining regions of the West of England are to a large extent composed of a peculiarly crystallized quartz known as cross-course spar, the silica of which has been derived from some unknown source, and when these cross-courses contain oxide of iron this also is often highly siliceous. Mr. Fox has suggested that the different character of the crystallized quartz veinstones in cross-courses as compared with that in lodes has some relation to the different action of local electrical currents in latitudinal and longitudinal fissures. This is certainly so in the West of England, but the same can hardly be said of mining regions generally.

The thick beds of sandstone which are so frequent and so characteristic of that part of Cornwall which lies immediately to the north and east of Truro, are often little consolidated, and consequently weathered into loose and incoherent sands to a considerable depth. So also the mica traps, which run from Roscreage beacon to Watergate Bay. But where these sandstones and traps are crossed by cross-courses, they are mostly found to be indurated and infiltrated with silica, not only in cracks, but throughout their mass. Thus they are able to resist denudation, and the sandstones in such cases stand up above the general level of the country, almost like dykes. This kind of local silicification is common, not only in connexion with rich mineral deposits, but also in situations where valuable minerals are not known or believed to exist.

The great cairns of quartz found at intervals from the Dodman to Mawgan-in-Meneage seem to be local supersilicifications of fossiliferous sandstones of Lower Silurian Age.

On the north coast, between Padstow and St. Ives, and also at Wheal Friendship, near Tavistock, in Devon, certain soft and and fine-grained sandstones and mudstones are found to be

locally silicified so as to furnish very fair oil-stones, hone-stones, scythe-stones.*

The siliceous alteration of limestones is a not uncommon occurrence in East Cornwall and West Devon, but in these cases the cherty bands and the silicified fossils have more of a non-crystalline or flinty character than is observable in the quartz veins and siliceous capels of the West of Cornwall. It should be remarked, however, that the quartz in the north and south lead-bearing lodes of Menheniot and St. Pinnock (Wheal Trelawney, Wheal Mary, Wheal Ludcott) is largely of a chalcedonic character, and so also is that of certain north and south veins near Withiel. This infiltration, with chalcedonic rather than crystalline quartz, is also met with in some of the fine-grained elvans such as those of Trelaver Downs in St. Dennis and Foxhole in St. Stephens.†

Chalcedonic quartz is not, however, limited to Devon and East Cornwall, since much chalcedony has been found in the lodes at Trevascus, Pednandrea, and many other mines between Redruth and Marazion, and also at Wheal Rose and Wheal Penrose, near Helston.

At St. Just opaline silica has occurred in many different forms and in considerable abundance at Botallack, Wheal Cock, and other mines.

The silicified sandstones of the greensand beds at Blackdown are often more or less concretionary and chalcedonic, while at Lyme Regis beds of sand have been extensively infiltrated with chalcedonic quartz.

Thus then, in the West of England, we have silica existing in secondary deposits in at least three distinct forms; each exhibiting marked modifications, as follows:—

(*a.*) Crystalline, as clear or tinted rock-crystal, as variously coloured and ordinary vein-quartz, as "fibrous" cross-course spar, as "sugary spar," "floatstone," &c., all practically anhydrous, and with specific gravity of 2·6 and upwards.

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* The famous Water of Ayr Stone is a silicified rock of this character.

† The supersilication of felsites and felspar porphyrys is very general in the Rio Tinto District (*Q. J.G.S.*, 1885), and also in the rocks of Seville (Macpherson, *Bol. de la. Com. del Mapa. Geol.*, Tomo VI.)

(*b.*) Chalcedonic, in concretionary or stalactitic forms, as red or brown jasper, as an opaque milk-white mass, as chert, &c., all anhydrous, and with specific gravity over 2·6.

(*c.*) Opaline, as pure opal, semi-opal, mangan-opal, ferruginous opal, &c., all hydrous, and with specific gravities varying from 2·2 upwards.

As to the origin of the different modifications of the first group, it would appear that they have been formed almost everywhere in the West of England and at all periods, from the very earliest down to or near to the present time. Except perhaps in the case of the cross-course spar, it is likely that these forms of quartz have been produced very slowly. The second group is much more local, but it occurs in many situations under conditions which suggest a rather rapid deposition. Probably its origin is directly connected with thermal springs.

The third group or opaline variety was also no doubt deposited by thermal springs and probably at a very high temperature. It is scarcely too much to say that in the whole of the West of England mining region, a rock which has not been infiltrated with some form of silica, since its first consolidation, or a fissure in which silica has not been deposited at more than one epoch, is a very rare exception. This being the case, we can hardly expect any direct connexion of origin to be traceable between the silica and the associated ore. There is quartz with the tin veins in the granite, but there is precisely similar quartz without tin; siliceous tin and copper capels abound, but there are very similar capels without tin or copper. Iron is found with the silica in some cross-courses, but in others it is absolutely free from iron.

Even the frequently observed connexion of silica with gold* is little noticeable in Cornwall, although that metal has been found in cross-courses in Breage, near Redruth, and at Poltimore in Devon.

* Interesting examples of recently-formed siliceous deposits containing gold, silver, cinnabar, and other metallic minerals, are described by Dr. Robert Oxland and Mr. J. A. Phillips (*Phil. Mag.*, Nov. 1868).

Mr. Dean remarks, "The silurian beds traversed by the gold lodes (in the Clogau district, where some very profitable mines were formerly worked) when hard and sharp and well silicified are the best for gold, the soft beds are unfavourable ("Notes on Gold Mining in Wales," *Rep. M.A.*, 1865.)

It is often supposed that silica has been deposited from acid solutions. It is probable, however, that this is not the case in general. The waters flowing from kaolin are always a little alkalien, while quartz-crystals are often found deposited on crystals of calcite or chalybite, whose form and even whose lustre has not been affected in any way.*

Mineralization. This is a term used by miners in a somewhat arbitrary sense, to denote an impregnation of a rock with iron-pyrites, copper-pyrites, blende, galena, or other sulphide ore—or by the oxidized or decomposed indications of such. It often happens that such mineralization, especially with the first-named substance, exists over large areas, in regions where no valuable deposits have been discovered. But the converse is scarcely the case, since there are very few mineral deposits of value known other than detrital deposits, which are not associated with rocks more or less mineralized. As in the cases of calcification and silicification there may be, and often is, evidence of the direct introduction of the mineralizating substance from without, while at other times there seems to have been a mere re-arrangement of an original or pre-existing constituent.

Pseudomorphism. In a large sense all such changes as kaolinization, serpentinization, and the like are examples of pseudomorphism. Technically, however, the term is limited to chemical changes in minerals of definite form, either distinctly crystalline, or at least exhibiting definite and recognizable "imitative" forms. For instance, when crystals of pyrites are found converted into limonite, calcite into cerussite, pyromorphite into galena, or felspar into kaolin, these would be at once recognized as pseudomorphic. It is evident, however, that the process is similar when extensive amorphous masses or disseminated grains are similarly changed.

The gozzans and the china-clay and china-stone "deposits" already mentioned are such examples, as much so as the altered veins of iron carbonate at Pawton, the altered beds of iron

* For some interesting experiments and instructive remarks on the decomposition and re-construction of rocks by siliceous infiltrations, see a paper by Alphonse Gages, read at the Geol. Soc. of Dublin, Nov. 18, 1858. (*Dub. Nat. Hist. Rev.*, Vol. VI.)

carbonate in Northamptonshire, or those of the north of Spain near Bilbao.

Pseudomorphic changes, using the term in its more limited sense, may be conveniently classed as follows:—

A. *Gain of components.*

1. Simple hydration, as when anhydrite is converted into gypsum, or muscovite into damourite.
2. Simple oxidation, as when magnetite is converted into hematite, or native copper into cuprite.
3. Addition of a compound radule, as when cuprite is converted into malachite.

B. *Loss of components.*

4. Simple loss of a constituent, volatile or soluble, as when cuprite occurs as metallic copper, or argentite as metallic silver.

C. *Substitution.* As when galena is converted into cerussite, or pyromorphite into galena, or chalybite into hematite.

The next three are pseudomorphs in quite a different sense.

D. Infiltration into a cavity formerly occupied by another substance. In this case, the form but not the structure will be preserved, as in the case of the Wheal Coates pseudomorphs of tin after orthoclase.*

E. Infiltration of organic forms, as the cassiterite in form of cancellated horn structure of the chalcedonic "Beekites" of Torquay.

F. Pseudomorphism of dimorphous substances. This is merely a molecular re-arrangement, as when calcite with its characteristic cleavage appears in form of aragonite or of stalactites.

All or nearly all of these modes of pseudomorphism are met with in the mining region of the West of England.†

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* See the author's "Handbook to the Mineralogy of Cornwall and Devon," article Pseudomorphs, Truro, 1876.

†At Wheal Coates, in St. Agnes, fine crystals of oxide of tin replacing felspar were found many years since in great quantities, in all stages from nearly pure felspar to nearly pure peroxide of tin. They were not, therefore, casts of tin in shape of felspar, but true replacements. See Tweedy, *R.I.C.* Similar occurrences, abundant, but owing to conditions of main mass of elvan, not isolated, were found at Terras, Belowda, Castle-an-Dinas, &c.

SEC. 11.—*Theories of Mineral Deposition with reference to Lode phenomena.*

The formation of our fissure-lodes (vein deposits, fissure fillings and capels) throws very much light on the origin of ore-deposits generally, and—thanks to the labours of a host of careful observers, among whom our former colleagues, W. Jory Henwood, Warington Smyth, and C. Le Neve Foster, deserve special mention—the leading phenomena of our lodes are very well known. It is generally admitted that the lodes themselves have originated either in actual fissures or in enlarged joints; that the lode-fillings are sometimes mechanical, but more usually chemical; that the mechanical filling was mainly derived from the sides (though perhaps in rare instances partly from the surface); that the chemical filling has always been effected by infiltrating and circulating solutions; and that it has taken place at various times, yet usually with a definite order of succession.

Having already given (Sec. 4) specific examples of several lodes, and of the characteristic phenomena of lodes in general in the West of England, we may now proceed to consider the more important theories of mineral deposits which have been adopted by various writers and at different times.

Confining the enquiry for the present to fissure-lodes, and to the metalliferous minerals, capels, and vein-stones occurring therein with which we are familiar in the west, we have to consider the following theories:*

a.—*That the fissures have been filled by injection.* So far as lodes proper are concerned, this theory may be at once dismissed, though it was formerly held as an axiom by many followers of Hutton, (not I think by Hutton himself) who were impressed by the phenomena of injected dikes, but who had little or no acquaintance with lode-phenomena. There are very few now who believe that metallic ores and veinstones have been injected into open fissures,† yet in another and more

* The history of opinion on this subject of the genesis of mineral veins has been very well dealt with by Mr. J. A. Phillips in his work on Ore-deposits, pub. in 1884, p.p. 73-100.

† There are still some geological writers, however, who still maintain the igneous origin even of masses of vein quartz. See Sterry Hunt, Mineral Physiography, p. 94 *et seq.*

limited sense the injection theory has a very important bearing upon the origin of ore-deposits, since the injections of elvan and other eruptive rocks appear to have been of vital effect in innumerable instances, especially as regards ores of copper and tin.

b.—That the fissures have been filled by vapours arising from below.

There are cases in which this process has undoubtedly been effective—as for instance in the deposition of sulphur, chlorides of iron and copper, specular-iron, and many other minerals in volcanic districts. These deposits, however, are not of the nature of true lodes. Indeed it is hard to see how fissures could remain open for the passage of vapours below the permanent water-level of a county, except very locally and under very exceptional circumstances. If there are in the depths of the earth open spaces in which vapours exist, these could not fail to be absorbed by the waters occupying the fissures nearer to the earth's surface, thus forming solutions which would come under the next head.

c.—That the matters in question have been brought into the fissures in a state of solution.

There are three modifications of this theory, one or more of which are now held, I believe, by almost all who have studied the phenomena of lode-fissures. They may be defined as

(1).—Infiltration from above (descension theory).

(2).—Infiltration from the sides (lateral secretion theory).

(3).—Solutions coming from below (ascension theory).

All of these modes seem to have been effective, and neither of them in any way excludes either of the others, while the subterranean circulation already discussed and illustrated would supply the necessary active agency for all. Let us examine the question a little more closely by the aid of the following propositions.

1. All the branches of the "solution and circulation theory," as it may be called, assume the pre-existence somewhere in the path of the circulating waters, of the veinstones and ores now found in the lode-fissures.

2. The veinstones and ores of the West of England may be conveniently considered as to their origin under five heads, of which examples are given in the following groups:

Group 1.—"Soluble" veinstones, as calcite.
,, 2.—"Insoluble" veinstones, as quartz.
,, 3.—"Soluble" oxidized metallic salts, as cuprite, malachite and chalybite.
,, 4.—"Insoluble" metallic sulphides, as pyrites, chalcopyrite, galena, and blende.
,, 5.—Schorl and other fluorine-bearing minerals with oxide of tin.*

3. All the elements contained in the substances mentioned above are known to occur as rock constituents, either as oxides, carbonates, sulphides, or silicates, and at such considerable distances from the lode-fissures as to lead to the conclusion that they existed there before the nearest lode-fissures were formed.†

4. Forchhammer, Bischoff, Dieulefait, and others have shown that the waters of the sea, in which most stratified rocks have been laid down, also contain notable proportions of many of the metallic and other constituents found in lodes,‡ and as already stated, Bischoff, Daubree, and others have shewn the existence in nautical waters of every one of the substances in question.

5. The original sources of the circulating solutions cannot perhaps be determined, but as they must be constantly replenished by rain water falling on the earth's surface, which is practically pure (except for the presence of carbonic acid) and free from all the substances referred to, we may consider the cycle of changes to begin with the action of pure water on rocks containing all the said substances.

* The expressions "soluble" and "insoluble" here refer to the actions of ordinary surface waters which are slightly acid. But they must not be understood too literally, since even silica is found in many natural "acid" waters, though it is more readily soluble in those which are alkaline.

† This has been particularly shewn by the investigations of Sandberger, and confirmed by Credner, Frick and others, although Sandberger's contention that *all* the metalliferous contents of the veins have been derived from pre-existing silicates is by no means generally admitted.

‡ Revue Universelle des Mines, 1880, p. 425.

Deposition of such substances as calcite in lode-fissures and cavities is easy to understand, since waters charged with carbonic acid will readily dissolve them out from rock masses when present, and a slight lowering of temperature or pressure will cause them to be re-deposited wherever a suitable cavity exists. The solution and redeposition of quartz and of many silicates can be and no doubt often is effected in a precisely similar manner, and the same may be said of such substances as cuprite, malachite, and chalybite, except that the solution will be sometimes preceded by the oxidation of pre-existing sulphides. These solutions and re-depositions will no doubt be more rapidly effected in proportion as the differences of temperature and pressure are greater, but ordinary temperatures and pressures will suffice, given sufficient time.

The relative depths to which the waters will penetrate before finding their way into fissures, and the particular parts of the fissures in which deposit takes place, will determine whether such deposits should be regarded as the results of infiltration from above or of lateral secretion, but it is quite evident that the transference of substances of groups 1 to 3 may take place without the solutions making their way to any great depths, and consequently without any notable elevation of temperature or considerable pressure.

More than 20 years ago Mr. Robert Hunt wrote as follows with regard to infiltration from above. "The view supposes waters to have penetrated from above, and that, in passing through the rock-fissures which were the natural channels of aqueous circulation these waters deposited, under the influence of what Sir Henry De la Beche called 'rock conditions,' and which Mr. Robert Were Fox and M. Becquerel referred to electrical action, their metallic and earthy salts forming the lodes as we find them...... my leaning is towards this hypothesis."* In expressing this opinion, Mr. Hunt does not specially indicate the sources of the "metallic and earthy salts" which are conveyed by the circulating waters, but as he speaks of water "penetrating from above," we may fairly assume that they would be free from metallic salts, at least at the start, and that they would acquire their solid contents

* *Trans. Roy. Geol. Soc. Corn.*, IX, p 22.

from the rocks in percolating through them. Mr. Hunt appears to have been considering particularly the veins of copper, but not at all to the exclusion of other veins.

Professor Ramsay suggested a similar origin for certain lead-veins in the following terms. "It had long been shewn that in Derbyshire fissures in anticlinals were unproductive, but those in synclinals productive of lead-ore, and this was explained by the lead (of the rocks) being dissolved by the water falling at the surface, which, travelling along the planes of stratification conveyed it from the convexities and towards the hollow folds of the beds."* Mr. De Rance said the same explanation applied to the lead veins of Alston Moor, which Mr. Wallace had described in 1861, and at the same time had suggested a similar leaching-out process.†

Each of these writers, it will be observed, assumes the previous existence of the copper and lead in the rocks at or above the level of the deposits referred to, and in such a state as to be leached out by percolating waters. This assumption may be readily admitted in the case of carbonate of lime and other veinstones of group 1, also perhaps in the case of the quartz and other veinstones of group 2. There is also no difficulty in applying it to the vein and joint segregations of oxidized metallic salts, chiefly carbonates, which are seen in the cupriferous sandstones of Alderley Edge, or to the carbonate of lead "pockets" so abundantly found at Leadville in Colorado. Doubtless, the wide-spread existence of such oxidized substances indicates an antecedent probability for the views expressed by Hunt and Wallace. If we could account for the sulphur of the metallic sulphides (group 4), the descension hypothesis would be still more widely applicable, but for this, and perhaps for the metals in combination with it, more deep seated sources or agencies would seem to be necessary. Metallic sulphides as such could hardly be transferred from the parent rock to the lode-fissure by circulating waters under ordinary temperature and pressure, and especially if the waters were neutral or acid, since sulphides under such conditions are either insoluble or are

* *Quart. Jour. Geol. Soc.*, 135, p. 659.

† *Ibid.*

subject to decomposition, with the production of sulphuretted hydrogen. It may indeed happen in rare cases that the sulphuretted hydrogen thus produced will subsequently by a reverse process give rise to sulphides in the upper parts of fissures, but this can hardly account for the immense deposits of sulphides met with in some lodes; as for instance the great copper deposits of Clifford Amalgamated and Devon Great Consols, and the large pyrites lodes at Wheal Jane.

The well-known mutual relations of ore-deposits and country rocks referred to in a previous section, certain rocks being "congenial" and others "uncongenial," lend great support to the hypothesis of lateral secretion, which is so closely connected with the descension hypothesis as to be hardly distinguishable from it.

If however the percolating solutions were alkaline, as from the kaolinization of felspathic rocks, and especially if these waters had been circulating through deep-seated rocks where the temperature was high and the pressure great, sulphides might no doubt be dissolved, transferred, and re-deposited without change, thus forming an example of ascension deposits. And in fact, deep-seated sources do seem to be required for the vein substances of group 4 in very many cases, and for groups 5 and 6 in all cases, either to give sufficient dissolving power to the solutions, or to supply the characteristic non-metallic components, or in some cases probably to supply the metallic components.

Let us consider these three cases separately. Suppose the surface waters to reach far down into the interior of the earth before making their way into a fissure and upward current. They will become hot, they will be subject to great pressure, and we may fairly suppose that they will in most cases become alkaline from the decomposition of silicates. If as Sandberger supposes, many of the silicates thus decomposed contain such metals as tin and copper, the solution will be charged with these metals. If sulphides are present in the rock, these will probably be dissolved unchanged and without decomposition; if chlorine or fluorine is present, and also oxide of tin (as a rock-component), fluoride or chloride of tin will be formed in the solution, and when it makes its way into the fissures or cavities, metallic

sulphides, cassiterite, and such fluor-bearing silicates as topaz will be deposited. Furthermore, if boron and oxide of iron are also present, as is almost universally the case, we shall have schorl in addition.*

It may, however, be remarked here that neither high temperatures nor great pressure seem to be absolutely necessary in all cases for the solution, transference, and re-deposition of tin oxide, for there is reason to believe that slightly alkaline waters under ordinary conditions of temperature and pressure are capable of slowly dissolving oxide of tin. In this way in recent times deer's horns appear to have been impregnated by circulating stanniferous solutions with oxide of tin.† Again, admitting the necessary dissolving power in the circulating solutions, we are still confronted with a difficulty in the existence of immense masses of sulphide ores, so characteristic of several of our mining districts, as was recently pointed out by Sir Warington Smyth. The solutions would by hypothesis dissolve such sulphides as actually existed in the country rock at the sides of the deposits. But this does not meet all the conditions. Sandberger urges that the ores are derived from original silicates contained in the country rocks,‡ and especially in granite, gneiss, and eruptive rocks generally.§ Granting all that he says for this wide-spread source of the metallic components, the question very naturally arises "whence comes the sulphur if not from deep-seated sources or (deep-seated) thermal waters?" Von Sandberger appears to admit, at least tacitly, a deep-seated source for sulphur, arsenic, &c., and if so, there seems no reason to deny a similar possible origin for much of the metallic substance found in the veins, even though portions of similar substance may have been derived from the country rocks. Our former Vice-president goes

* The part played by fluorine in kaolinization and in the formation of tin deposits have been particularly studied by Von Buch (*Min. Tasch.*, 1824), Daubrée (*Ann. des Mines*, 1841), Collins (*Cornish Tinstones, &c, Min. Mag.*, 1878).

† See *Trans. Roy. Geol. Soc. Corn.*, x, p. 98, *Cornish Tin-stones and Tin Capels*, Pl. xii, fig. 4.

‡ Stelzner's contention that the silver, &c. found by Sandberger did not really exist in the silicates, but in disseminated pyrites, has been met by Sandberger in his later essays. But this does not affect our present discussion.

§ In Cornwall, generally, only in acidic rocks of the granite type, scarcely at all in the basic eruptive rocks.

on to speak of "the over-powering contrast between the vast masses of mineral stored in the lodes and the puny sources of the theoretical supply. See a lode like that of Clifford Amalgamated, sixteen or eighteen feet wide, of cindery copper pyrites from wall to wall, or the thirty or forty feet of dredgy copper ore in the best parts of Devon Consols, or the massive dimensions of the lode at Dolcoath now, at four hundred fathoms deep, larger than ever; or again the courses of solid crystalline galena which have occurred in several of our more notable lead mines, yielding from five to ten tons to the running fathom, and such occurrences seem to be inexplicable by the process alleged." *

Certainly there is no indication that the country rocks ever contained these large quantities of sulphide ores: and for the sulphur at least we seem driven to suppose a deep-seated origin. Sir Warington goes on to our third case, and thus urges the necessity for a similar source for the metallic components. "Again, look at a rich part of one mining field, at a belt of killas rock extending over eight miles from Cligga Head to the south of Gwennap parish. In that space there are about a hundred parallel lodes, at one time a hundred more or less gaping fissures,† and if these are to be filled up by lateral segregation from the silicate minerals in the country rock, it will go very hard with the long narrow slices of the rock between the successive east and west veins to make up a sufficient quantity." ‡ He then goes on to consider the different contents of the parallel lodes underlying north and those underlying south, which traverse the very same rocks in the St. Agnes and Perran districts, and also to the different contents of right-running and of cross-veins in general, and observes "we should expect that if the sources were the same (viz.: the country rocks immediately contiguous to the deposits) the minerals would be of the same character, and could never exhibit so decided a contrast." He then refers to

* Smyth's Presidential Address, 1889, *Trans. Roy. Geol. Soc. Corn.*, Vol. XI, Part IV.

† This expression should not be misunderstood, for in the first place the hundred fissures referred to are obviously of three or four widely different ages, and in each "age" it is likely that only a very few of the fissures were even in any sense "gaping" simultaneously.

‡ *Ibid.*

the alternate "zones" of tin and copper ores in the mines of Cornwall, and concludes his remarks on this subject by saying "it seems to me that no leaching out of metallic mineral from the country walls will elucidate the problem."*

If a deep-seated origin is thus indicated for sulphur and for most of the metals occurring as sulphides, still more is it called for in the case of tin which is so very local in its occurrence yet so locally abundant; so rare as a component of true stratified rocks, so generally associated with eruptive rocks of the acidic type, which have evidently been formed in the depths, and so frequently an essential and in some cases apparently an original component of such rocks. There are indeed cases where tin-oxide exists disseminated in undoubtedly stratified rocks and in large quantities, and not associated with any fissure-lode which could be supposed to have been the channel of transmission from the depth below, as for instance the tin stockwork at Mulberry Hill already described. In these cases, however, it is certain that the rock has been very far below the earth's surface since its first formation and consolidation, and it seems probable that the tin in such cases was an original constituent, deposited from the waters with the rock material itself, and subsequently concentrated for the most part, though not entirely, into the minor fissures and shrinkage cracks as we see it. Had there been at the proper time a fissure in this rock, *i.e.* while it was still

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* *Ibid.* It should perhaps be remarked here that though the succession of zones of different minerals at different depth is notable enough, so that "the richest copper lode (Dolcoath) in the county in 1840 is now the richest tin lode," yet this alternation is often far too broadly stated, and in fact it cannot be said to be established anywhere in the West of England except in the neighbourhood of Carn Brea, and perhaps at the Phœnix Mines near Liskeard. In these localities it is true to this extent. (1) The upper portions of the lodes were worked for tin, little or no copper being present. But the gozzany character of these portions plainly indicates the former existence of sulphides now removed, and there is great reason to suppose that these sulphides were cupreous. (2) Several of these lodes subsequently proved to be rich in copper and ceased to be worked for tin. But there is reason to believe that notable quantities of tin were still present, though lost in the abundance of sulphuretted minerals. An examination of the burrows at Clifford Amalgamated shows that even there tin occurred with the copper. (3) It is certain that in the notable instances referred to above the (probably) once mixed tin and copper ores have given place to tin alone, the copper having altogether disappeared and the tin greatly increased in quantity.

deep-seated and while a circulating solution of sufficient temperature and pressure was still making its way through it, we might have had here a lode far richer than Dolcoath resulting strictly from lateral (though deep-seated) secretion. It may be that some of our lodes have been thus formed, and even some of the rich Camborne lodes; given then a sufficient cavity, a sufficiently powerful and abundant solvent and "rock-conditions," capable of causing deposit, and in a belt of country rock charged as that at Mulberry is, and the size of the largest "rich part" in a lode presents no difficulty that cannot be readily met. For we must remember that the most rigid application of the theory of lateral segregation does not forbid us to suppose that the large courses of ore referred to were the results of a local concentration of ore in the fissure itself, while the exhaustion of the country rock would only be proportionate to the average contents of rich and poor parts together.

The average width of the workable ore of the Great Dolcoath lode would probably not exceed 4 feet for the coppery and 8 feet for the tinny portions, with a general average of perhaps 6 feet. We have not the means of knowing with any degree of accuracy the yield per cubic fathom of the coppery portion of the lode, but we shall probably not be far wrong in taking it at 4 per cent. of copper, while the tinny portions may be taken at 2 per cent. with an equal degree of probability. The values, taking into account differences in the cost of (dressing) preparing for market, would be much the same, so that we may follow out our comparison on the tinny portion alone.

The 30 fathom belt of tin ground at Mulberry will thus be seen to have yielded, per linear fathom, nearly twice as much tin as the Dolcoath lode, or in other words, if concentrated into a suitable fissure it would have made a lode either twice as large or twice as rich. The similar belt at Great Wheal Fortune in Breage would have supplied a lode four times more productive than that at Dolcoath. The great value of the Dolcoath lode (and equally of the other instances cited by Smyth) consists therefore not so much in the absolute quantity of its metallic contents as in the natural concentration which has brought it into, or into the immediate neighbourhood of, a narrow fissure.

Origin of metallic deposits apart from metallic silicate rock crumblings.

Still another argument for the efficacy of thermal waters in bringing up lead and silver from the depths, in regions where there are no eruptive rocks, is thus stated by Prof. Smyth. "Finally, how are we to cope with those districts in which we find little or no mica, no augites or hornblendes, the large areas for instance of clay slates in central Wales, where we have no granite contacts and no intrusions of igneous dykes, and yet scores of well-developed lodes, many of them exceedingly productive of lead ores and often rich in silver?....It seems to me that no leaching out of metallic mineral from the country walls will elucidate the problem, but that we are nearer its solution by invoking the aid of thermal waters."*

The absolute necessity of such chemically charged thermal waters seems to be admitted by all who have made a special study of the lodes in the West of England, and by most of those who have recently studied lodes in other countries.†

We thus reach the conclusion that in most cases sulphur, part at least of the metallic bases of such sulphides as pyrites, chalcopyrite, galena, and blende, oxide of tin, and the various fluo-silicates and fluo-boro-silicates have a "deep-seated" origin, and that they have for the most part been brought into their present positions either directly by the agency of ascending thermals, or indirectly by the elevation and intrusion of eruptive

* Smyth, Pres. Address, op. cit. p. 195.

† Lindgren, in referring to the silver deposits of the Carlico district in California, says: "on the whole it seems to me most probable that ascending thermals have extracted ore and gangue from the eruptive rocks at a certain although not exceedingly great depth, and that for chemical and physical reasons the principal precipitation took place (in complex fissures) near the surface......... Most of the ore-deposits occur in liparite or in its tufas, as veins along fractures and dislocations of a more or less regular character; as simple, once open and subsequently filled fissure-veins; as impregnations along complex fissure-systems (gangzüge) or filling and cementing more or less extensively fractured zones (Trümmerzüge). The gangue is predominantly barite with jasper; the present ores are haloid salts of silver, hydrosilicate and carbonate of copper resulting from primary rich silver sulphides and copper pyrites." *Trans. Am. Inst. M. Eng.* Except for small differences in the character of the ores and rocks this description would apply well to the Torreon Mine in Chihuahua. See *Journ. R.I.C.*

rocks such as granite, felsite, and diabase, containing (*a*) metalliferous silicates or (*b*) metalliferous sulphides, which subsequently are carried off by percolating waters and deposited where we find them.† It seems to me this hypothesis will meet all the facts as we know them.

Thus the phenomena of "congenial" and "uncongenial" strata as observed by the miners in the West of England, and the different enrichment of the lead veins in the North of England as they cut through successive and alternating strata of limestone grit and shale, as set forth by Wallace in 1861, agreeing as they do with the most literal interpretation of the lateral secretion hypothesis, agree equally well with the idea that the fissures are fed by ascending metalliferous thermals. For, we may readily and fairly suppose that, the circulating solution being the same and complex, certain rocks have greater, or at least different, precipitating capacities than others, or that some supply better cavities than others.

The following conclusions seem fairly deducible from what has been here put forward.

1. That as a rational "lateral segregation" hypothesis accepts and includes "descension," so a rational "ascension hypothesis" must accept and include both lateral segregation and descension, and that all three have operated powerfully and and extensively in the production of the ore-deposits of the West of England.

2. That sublimation has acted effectively in ore-deposition, and especially as regards the elements sulphur and arsenic.

3. That injection has also been powerfully effective, but chiefly by bringing up ore-charged rocks from what may be called the zone of vapour to the zone of subterranean circulation.

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† It is of course admitted that many comparatively modern stratified rocks contain metallic compounds, and there is great reason to believe these in many instances to have been present in some form when the strata were first laid down, the substances in question having been present in the waters. But these waters must have received such components in the first instance from mineral springs rising from the earth, except such portions as, it may be argued, were originally condensed into the first waters from the first atmosphere.

4. That the subterranean circulation which I have endeavoured to illustrate, aided and supplemented by electrical transference and re-arrangement, by chemical re-actions going on within the deposits and by the forces of crystallization and its allies, will account for all the phenomena of lode filling.

SEC. 12.—*Theories of Impregnation.*

In the Presidential address of Prof. Smyth quoted in the last section, reference is made to the "feeders" observed in connection with many lodes, and to the frequently associated mineralized "country" rocks, in the following terms:—"When in the neighbourhood of a vein you find strings and specks of some of the ores which it contains in bulk, some miners will not hesitate to look upon them as "feeders" or contributories to the vein which come in from the "country." Others will rather look upon them as impregnations from the lode."*

It might seem at first a mere problem of chemical analysis to settle this point, but a little consideration will show that this is not the case. I cannot do better than quote here the words of Dr. Henry Wadsworth of Massachusetts, who observes "since ore-deposits are generally associated with altered or metamorphosed rocks, and occur in regions in which thermal waters have been active, the country rock would naturally be more or less charged, and sometimes completely decomposed. In the process of the formation of the ore-deposit it may happen that the ore-material will be entirely removed from the adjacent rocks (*i.e.* to form the deposit in question), or this rock may have deposited in it ores which never existed there before, or, again, the ore-material may have been brought from a distance by the percolating waters. From the above it follows that chemical analyses alone, either of the country rock or of its enclosed minerals, lead to unreliable conclusions as to the source of the ores, and hence it is unphilosophical to build any general theory upon such analyses."†

Clearly then it is not always easy—or even possible—to decide even in the simplest case whether the country rock

* *Op. cit.*, p. 90.

† Wadsworth. "Theories of Ore Deposit." *Proc. Bost. Soc. Nat. Hist.*, May, 1884, p. 201.

has been impregnated from the fissure or the fissure filled from the country. The opposing views may be illustrated as follows:— Let fig. 13, pl. IX, represent a portion of a rock mass containing stanniferous silicates regularly disseminated through it. The rock is permeable to a solution which is capable of decomposing the silicates in question. Now we may suppose that the solution circulates through the mass of the rock, and (1) merely changes the silicate into oxide of tin, *in situ*, carrying off the silica, or perhaps depositing it in the vicinity of the oxide particles. But (2) if the rocks be fissured, as in fig. 14, and the circulating solution is flowing towards the fissure from each side, it may decompose the silicates as before into oxides, but at the same time transfer some of the particles towards the fissure, so forming an accumulation of tin oxide near its walls at the expense of the general mass of the rock. And in proportion to the length of the process, and to the extent of the mass of rock thus subject to the transferring solution, may we expect will be the width and richness of the enriched bands. As in the former case the silica may either be deposited with the tin oxide or carried farther by the issuing solution. A further development of the very same process may lead to a deposition of tin oxide, or of quartz, or both, with varying mutual relations, in the fissure itself as a "leader." Let us speak of this hypothesis, which assumes a flow and transference from the mass of the rock towards the fissure, as (x). The same phenomena of leader and of enriched band may be equally well explained by another and opposite hypothesis (y), which supposes a stanniferous solution flowing along the fissure, which may or may not deposit ore material or veinstone in the fissure itself, but which permeates the rock to a certain distance on either side of the fissure, depositing ore material or veinstone in that bordering belt; any stanniferous particles already in the rock being thus practically unaltered. I doubt not that hypothesis (y) applies in some cases—where definite lodes exist—even though the whole mass of country rock may have been originally impregnated with ore material, but it appears to me that the former hypothesis is far more able to account for such phenomena as are seen at Mulberry and other similar stock-works (fig. 1 Pl. VIII); in fact that the fissure when very small forms rather the exit for the spent liquors, and not the entrance for the charged solutions.

Let us take another illustration. In fig. 15, Pl. IX, which represents the case of many small and rich tin-lodes in granite, the tin might be supposed to have come up or along the fissure until it was quite full, the stanniferous solutions meanwhile acting upon the solid granite, converting it into kaolin, depositing quartz and carrying off alkali at the same time. But we may equally well suppose, in accordance with the circulating theory, that the solvent percolating through the mass of the granite dissolves out the tin from the original stanniferous silicates, or from any other combination in which it may exist, and on reaching the fissure deposits it there; only kaolinizing the granite in the neighbourhood of the fissure and not throughout the mass of the rock, because there only was it possible for the alkalies to be freely carried off and for the liberated silica to be deposited. It seems to me that this view is strongly supported by the phenomena of the carbonas, stock-works, and capels, and by what are called impregnations generally.

The great carbona in St. Ives Consols (fig. 2, pl. VIII) was 720 feet long, and though very variable in width and height, averaged perhaps 30 feet. At a moderate computation 60,000 tons of tin-impregnated granite must have been extracted from this carbona, yet its only communication with the standard lode was but a few inches in width and height, and those with other lodes much smaller still. Such small channels might very well serve for the continuous discharge of what may be called spent liquors coming from all sides, but could hardly serve for the entry of enriching solutions from the lode fissures to what was really a kind of blind alley.

The argument is still still stronger in the case of impregnation at the South Wendron Mine, (fig. 6, pl. VIII) for here the traversing fissure is a mere crack which rarely contains tin at all. The wide, even, and sparing distribution of the tin in the killas stockworks, which are not associated with definite lodes, seems to afford strong reasons for regarding them as originally stanniferous beds, as already indicated. This hypothesis helps us to understand how it is that so large a quantity of tin could be localized without the aid of any lode sufficiently large or continuous to serve as a channel from considerable depths. It

also agrees with the fact that, however numerous the individual tin "strings" may be, and they are sometimes a score or more to the yard (fig. 1, pl. VIII), yet that the killas between always contains traces at least of tin, and sometimes actually more than the aggregrate of the "strings," which alone it is possible to save by economic treatment of the whole mass owing to the extreme fineness of the tin in the rock between the strings.

These strings appear to be no more than filled shrinkage cracks, those which are now more than capillary in size having been enlarged by the crystallizing forces. It does not seem likely that any of them were ever really open fissures in the ordinary sense of the term.

The minerals associated with the tin in these stock-works are precisely what they are in so many other situations, viz.: gilbertite, schorl and quartz; with, rarely, topaz and wolfram. Fluor and apatite are either very rare, or altogether absent. Usually in these little "strings" the cassiterite is more abundant than all the rest of the components taken together, so that as the term is usually applied there is no veinstone. It seems impossible to believe that a band of rock 20 or 30 fathoms wide can have been impregnated with so large a quantity of tin, brought from so far by solutions flowing through these comparatively trivial channels. Can we imagine that such a solution passing through a veinlet, often less than one sixteenth of an inch in thickness and only extending a few yards in length or depth, has impregnated the country rock for a foot or more in some instances on either side? Rather it would appear that a sufficient solvent power had existed in the interstitial fluid soaking through rocks already saturated with tin particles; in fact that in these instances at least the old sediments which now form the bulk of Cornwall were, in their deeper portions (which are now uplifted on the flanks of the granite), already stanniferous before the granite began to be uplifted. Thus as regards these stockworks in killas which are unconnected with distinct fissure veins, it seems that we must look to what has been called lateral segregation for the concentration in the strings; and as to the tin itself, although it may originally have been brought to the surface and poured into the ancient seas or lakes by means of thermal springs, yet that the springs were not less ancient than

the beds in question. We can therefore easily understand why these tin-bearing rocks have yielded no fossils, since no higher forms of life at any rate could exist in a sea charged with highly poisonous soluble compounds of tin-fluorides, fluo-chlorides, fluo-borates, and fluo-silicates.*

As for the tin stockworks in killas which are associated with definite lodes, such as Great Wheal Fortune and Pednandrea, Von Cotta's hypothesis as applied by H. C. Salmon to the great "underground stockwork" at the latter mine in 1862 is as follows: "I consider this great deposit as eminently characteristic of a class of stanniferous formations common enough in Cornwall, but which are usually classed as lodes......The real fact is that there was a fissure, but often only a very small one, from which a metamorphosing and replacing action appears to have emanated, extending to a greater or less distance, metamorphosing the neighbouring rock into a capel and impregnating it by replacement with oxide of tin. When this is confined *to* a moderate width, and where the tin does not extend away in veins at right angles to the lode, the miner classes it all as a "*lode*," and properly so. As to "walls" which some appear to consider the criterion of a true lode, they may in these highly dislocated districts be frequently met with *ad infinitum*; and in such deposits as those referred to it is not unusual to find that half-a-dozen "walls" have been adopted in succession as the true wall of the lode and abandoned. .....I do not of course mean to imply by this that there are not many lodes wholly confined within the walls of an original fissure—lodes in the popular geological sense. I only wish to point out that there are many lodes of a different character, and this Pednandrea deposit is characteristic and worthy of study as forming a link between lodes of this class and those still more irregular deposits called carbonas in the extreme western districts of Cornwall."†

* On this subject the following suggestion was made by my son H. F. Collins and myself in the year 1884. "The waters were so strongly impregnated with chemical solutions—from mineral springs preceding the granite irruptions—that nothing could live. If this were the case the sediments would also be highly charged with chemical substances, and the subsequent segregation of these substances into fissures formed at a later date has given us the lodes of Cornwall." *Journ. R.I.C.*, Vol. VIII, part 2, p. 166.

† *Mining and Smelting Magazine*, Sept., 1862, pp. 143-4.

With all that is here said I entirely agree, but it seems to me that several of the phenomena of such stockwork deposits become clearer and easier to understand, if we suppose that the rocks in which the fissure has been opened was already charged with tin in some form, disseminated through the mass, and perhaps even concentrated into shrinkage cracks before the opening of the fissure.

If there is reason to believe that the killas stockworks represent rock masses permeated with tin, and that at Wheal Music with copper, before fissuring, much more is this the case with such granite stockworks as those at Carrigan and Rock Hill, and with such stanniferous elvans as that at Wheal Jennings. The same may be said of the copper stockworks at Wheal Vyvyan. But these of course are known to be of much more recent origin.

Capels. The substances known in Cornwall and Devon as capels may be described as highly altered and usually silicified bands of country rock, bordering a more or less distinct fissure or fissure-filling. The term is sometimes applied to a silicified or mineralized band at the side of a fissure traversing granite or even elvan, but most well-marked capels occur in killas.* Fig. 16, plate IX, illustrates one form of capel in killas.

Tin capels contain particles of tin-oxide in notable proportions, though not always in quantities sufficient to pay for working. The contents of the actual fissures (the leaders) in these cases are often quite unimportant from the miner's point of view, as in the case of the greater portions of the tin lodes on each side of Carn Brea Hill. In all the mines of this district the chief part of the tin is obtained from the capel, which extends sometimes for several fathoms on each side of the fissure or lode proper, which is sometimes a mere joint in the rock.

* The word capel (at Penhalls) is applied to a rock which appears to me to be simply an altered killas, a killas which has been greatly acted on by mineral solutions and changed from a soft slaty rock into a hard dark-coloured compact mass of quartz and schorl: these minerals being arranged in streaks following the original lines of stratification of the killas. In addition the capel is generally full of short lenticular veins of quartz, and is intersected by numerous little strings of cassiterite and chlorite. Foster, *Trans. Roy. Geol. Soc. Corn.*, IX, 207.

The mineralized bands are worked away as far as they are found to yield mineral enough to pay the cost of working. Consequently, as the price of tin varies within wide limits, the estimated or stated width of the paying ground known as "the lode," may also vary at different times, but in the Camborne and Illogan districts the average width may be taken at from 4 to 8 feet.*

Since in all cases it is the workable part of the capel (including the "leader" when present) which is described as the lode by the miners, many wrong impressions have resulted as to the width of the ore-bearing fissures in the West of England. Thus the table of lode-widths already given from Mr. Henwood's "Address," though fairly accurate as regards copper lodes, where workable capels have always been either very rare or altogether absent, is to a considerable extent misleading as regards tin lodes or lodes containing both tin and copper, unless the distinction pointed out be borne in mind.

The most noteworthy point in connection with these capels is the enormous amount of silica present. Doubtless we might suppose the interior of the earth—whatever that phrase may be taken to mean—quite capable of yielding this silica, but the circulating waters of these fissures could hardly bring up so much. The first effort would probably be to coat the wall with an almost impermeable layer, after which the silicia would make its way outwards still in solution. If we suppose the silica to be derived from the county rock, our difficulty is lessened if not altogether vanishing.

There is much reason to believe that the quartz of capels and of quartz veins is, as already indicated, the result of solution in and deposition from alkaline solutions.†

* In this width, however, the tin is still disseminated somewhat irregularly, so that it is often necessary to break a great deal of ground that will not pay for subsequent treatment, and even to raise such "deads" to surface. Of the whole bulk of the lode-stuff broken in the Camborne district, probably not more than one half is actually treated in the stamps, and the average produce of this portion in "black tin," as finally "cleaned" and sold to the smelter, does not exceed 2 per cent.

† At New Rosewarne and other mines in Cornwall quartz has been frequently found deposited on chalybite, dolomite, and even on calcite crystals, the surfaces of which are entirely uninjured from corrosion. This could hardly be the case if the quartz were deposited from acid solutions.

The Great Flat Lode described by Dr. Foster in 1878, is a fine example of a capel tin lode.* The microscopical structure of certain tin capels was fully described and illustrated in the author's papers published in 1880-82.†

The constant association of schorl and tin has been already referred to. Indeed tin is scarcely ever present without schorl, although schorl very often occurs where there is no tin.

Tourmaline schist is rarely quite free from tin, but many of the thin films of schorl between the beds at the Parka mines appear to be absolutely devoid of tin. Here the schorl occurs in thin knife-blade films, absolutely black, but fading gradually away to red yellow or white at a short distance from the fissure. In other places quite near "floors" of tin occur in great abundance.

SEC. 13.—*On the localization of Mineral Substances in the West of England Mining District.*

The contrast between the vast quantities of alkalies present in the constituent minerals of the crystalline rocks, (and in the eruptive rocks which appear to have been derived from the crystallines by more or less complete fusion), and the small proportions existing in the rocks of the sedimentary series, is one of the most noteworthy in the whole range of chemical geology. A similar rarity of alkaline constituents characterizes the great bulk of our mineral deposits, whether stratified beds, segregations or fissure-veins.

The alkaline constituents now so abundant in the seas and in vegetation have probably been derived in great part from the crystalline and eruptive rocks by the agency of ascending thermal currents (springs), as suggested by Dr. T. Sterry Hunt in his crenitic hypothesis,‡ and there is great reason to believe that the mineral deposits themselves have been derived from the same primary source, as we have endeavoured to show in the foregoing sections.

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* *Quart. Journ. Geol. Soc.*

† On Cornish Tin Stones and Tin Capels, *Min. Mag.*, Vol. 4 and 5.

‡ *Mineral Physiology*, &c., 1886, p. 132, *et. seq.*

If this primary origin of mineral substances be admitted, it might at first seem that the elements referred to would be found everywhere, though differing somewhat in the proportions present. In the strictest sense this may be so, but it is not so in any practical sense. There are indeed certain elements, such as silica and alumina, which are scarcely ever absent, even in notable proportions, over any considerable area.* Similar proportions of oxides of iron also are not often absent, although the same cannot be said of the definite compounds of iron with sulphur and arsenic. Gold and silver too seem to be very widely distributed, but these are so valuable that even minute proportions, such as would be overlooked in the case of less valuable substances, are noted. But there are other elements and combinations which, common enough in some localities, are present not at all or only in very minute proportions in others, and this not only in the case of large areas, but even in the different parts of such a small area as our West of England district.

The elements and mineral substances whose distribution is to be here discussed will be dealt with in groups as follows:

Group 1.—Fluorine, boron, tin, and tungsten.
,, 2.—Sulphur, arsenic, copper, zinc, lead, antimony.
,, 3.—Iron, manganese, nickel, cobalt, bismuth, uranium, titanium, chromium.
,, 4.—Phosphates.
,, 5.—Carbonates ores and veinstones.
,, 6.—Barium, strontian, cerium.
,, 7.—Gold, silver.
,, 8.—Carbon and hydro-carbons.

GROUP 1.—*Fluorine, Boron, Tin, Tungsten.*

These are perhaps the most notable of the irregularly distributed elements in our district, and it will be shown that they are very specially associated with each other.

Fluorine occurs in tourmaline (schorl) and in fluor spar, also in much smaller quantities in such minerals as gilbertite,

* Some remarks on the local occurrences of special forms of silica were made in a previous section of this chapter.

topaz, and apatite, the most abundant source being the first-mentioned.*

Tourmaline is an important constituent of very large areas within our district; in granite and its various modifications (schorlyte, luxullyanyite, &c.); in tourmaline schist and in tin capel. Probably at least one-tenth of the entire district, in round numbers some 200 square miles, is thus permeated with tourmaline, and to the average extent of one-tenth of the entire mass. Now the rocks of this district weigh very closely upon two tons per cubic yard, so that each yard in depth of this large area will weigh near 1,240 millions of tons, and by our estimate one tenth of this, or 124 millons of tons, consist of tourmaline. Tourmaline, by analysis, yields from 1·49 up to 2·70 per cent. of its weight of fluorine. If we assume an average of 2 per cent., our 124 millions of tons contain no less than 2,480,000 tons of fluorine. This be it remembered for each yard in depth.

Fluor spar is another, though far less important, source of fluorine. It has been found in many of the copper lodes and lead lodes of the district, as well as, sparingly, in a few of the tin lodes. Also it has been met with occasionally as a constituent of the granite (as at Wheal Daniel) and of the modified and kaolinized granite rock known as China Stone or Petuntzyte, notably in the parishes of St Stephens and St. Dennis. The absolute quantity of this fluor spar must be very difficult to estimate. It may however be worth while to make the attempt, however roughly. If we assume the existence of 500 veins, averaging one yard wide and continuous for an average of 500 yards in length, we have a total area of 250,000 square yards, or a little less than one-twelfth of a square mile. If in this area we assume further that the fluor spar forms one-twentieth of the whole vein contents, probably a reasonable estimate, then as fluor spar contains about 47 per cent. of fluorine, there will be thus indicated 11,750 tons per yard of depth.

It is probable that fluor spar as a rock-constituent occurs over a much larger area than as a veinstone, perhaps even over a square mile in all. But it exists there in much less proportions, probably not over one per cent., and this would give us a further quantity of fluorine of something like 29,000 tons per yard of depth.

* The chief localites for this and other mineral substances mentioned are given in the Author's "Hand-book to The Mineralogy of Cornwall and Devon," Truro, 1876.

If we double these last last figures for the fluorine existing in gilbertite, topaz, apatite, and other rare or widely scattered minerals, whether occurring as rock-constituents, or in the veins, we reach in round numbers a total of two millions five hundred and fifty thousand tons of fluorine per yard of depth. Thus it is evident:

(*a*).—That fluorine is an important constituent of the Cornwall mining region.

(*b*).—That it is localized as regards tourmaline in one-tenth, and as regards fluor spar and other minerals in about two-thousandths of the entire area.

There are indeed traces of fluorine to be found by careful analyses in many other parts of the mining district, but the element for all practical and most theoretical purposes may be regarded as absent.

Boron. This element is with us confined to the tourmaline, of which, like the fluorine, it constitutes about 2 per cent. Consequently we may estimate the boron present at about two and a half millions of tons per yard of depth. This element hardly occurs in the West of England excepting in tourmaline, and it is probably entirely absent from the rocks outside the tourmaline area.

Tin has hardly been found in the district, or indeed in any district except as cassiterite.* It is far less abundant than either fluorine or boron. The actually impregnated area may be roughly estimated to contain, or to have contained, tin as follows; of course not counting the stream tin, which represents the results of a very large denudation:

One thousand lodes (with their branches, carbonas, or other adjuncts) averaging 1,000 yards long and one yard wide is equal to one million yards of surface area. And this reckoning one per cent. of (metallic) tin would give 20,000 tons per yard of depth.

* The tin occurring in stannite (tin pyrites) may be finely divided cassiterite, at any rate it is not, as was once supposed, a true sulphide.

Fifty stockworks, averaging 250 yards long and 20 yards wide, and yielding an average of a quarter per cent. of metallic tin, 1,250 tons per yard. Together 21,250 tons of metallic tin per yard of depth.

The whole area thus indicated would be a little less than half a square mile; outside of this area tin can hardly be said to exist at all as a rock or vein constituent.

Tungsten. This element is far less widely distributed than tin. From all the lead veins, most of the copper-veins, and even many of the tin-veins it is altogether absent; while it hardly exists at all as a rock constituent outside the veins. Yet in the form of wolfram, which contains about 60 per cent. of tungsten, it is locally abundant, as for instance at East Pool, Great Beam, and Drakewalls Mines. Small quantities of tungsten also occur as scheelite and as zippæite. Still it is probable that on the whole tungsten is not more than one-tenth, perhaps not more than one-twentieth as abundant in Cornwall as tin.

Here then we have four elements, each occurring in considerable abundance, though limited to very small actual areas in a not very large mining district, and all four are peculiarly and intimately associated with each other. For if we take the area which contains the whole of the tourmaline, in other words that which contains all the boron and nearly all the fluorine, we shall find that it includes also both the tin and the tungsten. But as the tourmaline area is much larger than the tin area, we may have tourmaline without tin, but not tin without tourmaline. Similarly there may be tin without tungsten, but not tungsten without tin.

These mutual associations have been fully discussed elsewhere,* and the conclusion seems irresistible that fluorine in solution has been the tin-carrier, bringing tin up from considerable depths to what may be called workable depth, and even to the actual present surface in some instances.

Whether boron aided in this or not is perhaps doubtful, since the direct combinations of boron with tin are little if at all known. It would seem, however, that when once locked up

* Cornish Tin-stones and Tin-capels, p. 33, *et. seq.*

with silica and iron in the very stable mineral tourmaline, that neither fluorine nor boron have any tin-carrying power. Certainly the great bulk of tourmaline bearing rock everywhere seems to be devoid of tin.†

GROUP 2.—*Sulphur, Arsenic, Copper, Zinc, Lead, Antimony.*

The first portion of this second group of elements is often rather closely associated with the compounds of the first group, but the second portion is somewhat widely diverse in its modes of occurrence; and all except perhaps arsenic occur at times in considerable abundance away from the elements of the first group.

Sulphur seems to be the constant and characteristic associate of the group—as much so as fluorine and boron in the first group—indeed more so, for the combinations with sulphur are more direct. Still it must be admitted that in our district sulphur minerals are less widely distributed than are tourmaline and fluor spar.

The most extensive vein deposits of sulphides are or have been the great copper veins of St. Just, Breage, Camborne, Redruth, Gwennap, St. Austell, Liskeard, and the Tamar valley; the great lodes of iron pyrites at Wheal Jane and Nangiles; and the large mispickel lodes of the Tamar valley. All these are very closely connected with what may be called the fluorine and tin area. Sulphur is also largely associated with zinc (as blende) not only in some of the districts just mentioned, but also in many of the veins of galena, and in some of those yielding lead and antimony. Probably, however, the greatest actual amount of sulphur occurs in the large quantities of disseminated iron pyrites found in the rocks of the fossiliferous sedimentary series, and often far away from the tourmaline bearing rocks.

Arsenic. The only important source of this element in Cornwall is the mineral mispickel, though it also occurs to a small extent in connection with nickel, cobalt, copper, and other substances. The veins containing the arsenic compounds are

† The immense deposits of boracic acid, free, or in combination with lime or with alkalies, as seen in Italy and more markedly in California and Nevada probably indicates the absence of the fluorine or iron necessary to fix it in the mineral tourmaline, which is very rare in each of these regions.

mostly situated in the slaty rocks (killas) near to the granite, but occasionally in the granite itself. In the former situations, as in the great siliceous lodes of Devon Great Consols and Gawton in the Tamar valley, it is in the whole more closely associated with copper than with tin, although both metals are generally present. In the Camborne district it is perhaps more closely associated with tin than with copper, and sometimes copper is altogether absent. On the whole it is probable that arsenic in the veins of the West of England is less abundant than tin, though much more abundant than wolfram. As a rock-constituent it is like wolfram, very rare.

Mispickel contains about 46 per cent. of arsenic combined with nearly 35 per cent of iron, and about 19 per cent of sulphur.

Copper. The number of minerals containing copper is very great, but practically they are all confined to the veins and rock-joints near veins. The rich gray ores of the St. Just mines, of the Godolphin mine in Breage, of the Camborne and Redruth mines (whence the richest is sometimes called Redruthite), and of some of the mines near St. Austell; the rich red and black oxides and blue and green carbonates of the Caradon district; as well as the rarer arseniates, phosphates, and uranates, and the native copper of many of the coppery gozzans; all seem to have been derived by chemical and electrical agencies from the double sulphide of iron and copper known as chalcopyrite, which contains when purest nearly equal proportions of copper, iron, and sulphur.

The great cindery courses of ore at the Gwennap mines, and the still larger siliceous ore-masses at Devon Great Consols, sometimes formerly as much as 40 feet wide, strike the imagination with their brilliant appearance, but unlike the best tin-veins they have for the most part become impoverished in depth, so that copper mining, which began in comparatively recent times, has now sunk to very small dimensions; and has been for the greater part of its history far inferior in importance to tin mining.

The best copper deposits have always been in veins near to but not actually in the granite. Some copper has also been found in veins at considerable distances from the granite, quite

away too from tin and from tourmaline. Even when it is directly associated with these substances it seems to have had quite a different origin.

Copper as a rock-constituent, apart from definite veins, is almost non-existent, and the absolute quantity of copper in the West of England must be far less than that of tin.

Zinc in Cornwall scarcely occurs at all except as the sulphide (blende), and it is almost exclusively confined to the veins in which iron, copper, or lead ores are found. Occasionally it is met with in the tin-veins as at Wheal Metal in Breage, but only in small quantities, unless notable quantities of copper are also present. In such cases it is of course near the granite junctions; but when it occurs in lead veins, like copper ores under similar conditions, it is found far away from such junctions.

Some of the zinc veins have been very large, as for instance at Great Retallack and Duchy Peru in the parish of Perran. Very much blende was thrown away in the old burrows, or left behind in the upper levels of many of the mines, and especially in those between Truro and St. Agnes; there having been formerly no sale for blende. Many of these old mines and burrows have been re-worked in comparatively recent times. Still the product of zinc ore in our district has never been really large even as compared with copper.

As a rock-constituent zinc is very rare, and the absolute quantity of zinc in Cornwall has probably not much exceeded the absolute quantity of tungsten.

Lead. This element also occurs almost exclusively in veins, and as a sulphide (galena), and almost always at considerable distances from the granite. The best deposits, as at East Wheal Rose and the Menheniot mines, have mostly been associated with sedimentary rocks of a fossiliferous series. As already mentioned ores of zinc and copper are often found with lead ores in the veins. Tin however occurs near lead only very rarely,* and even then is not intimately associated with it.

* The most notable exception is at Budnick in Perranzabuloe, described by W. J. Henwood. *Trans. Roy. Geol. Soc. Corn.*, V.

The galena of the district is almost always notably argentiferous, ores running from 30 up to 100 ounces of silver per ton being common. At times the production has been considerable, yet it cannot be said that lead mining has ever been a really important industry here compared with the mining of copper, and still less as compared with tin. It has now (1891) almost absolutely ceased to exist.

A considerable number of rare minerals resulting from the decomposition of galena have been found in the gozzany portions of the lodes, but rarely in workable quantities. As a rock constituent lead ores have scarcely ever been seen in the district, and on the whole it would perhaps not be far wrong to reckon lead as about equal in quantity and in area of distribution with zinc, though the areas are not quite coincident.

Antimony. This element has usually occurred with lead, and under like conditions; mostly as a sulphide, and confined to veins in stratified rocks of a fossiliferous series, at a distance from the granite. It has always been far less abundant than lead.

In group 2 we have a number of elements very intimately associated with each other, more particularly through the non-metallic sulphur, which may have come in part from "deep seated" sources, as is almost certainly the case with fluorine and its associates of the first group. But there is a notable association of some at least of the sulphuretted metals (lead and antimony) with the stratified rocks of a fossiliferous series. It seems probable that at any rate galena and antimonite, and possibly too part of the blende and chalcopyrite, may have been derived directly from these rocks, or from others formerly over-lying them and now denuded away; though primarily coming from deep-seated sources by means of ancient springs, which mineralized the waters in which the rocks in question were laid down.

THE DIAMOND PROSPECTING CORE DRILL.

BY STEPHEN ROGERS, F.G.S.

One of the most important considerations in the development of mineral property is the preliminary "prospecting," by which the exact position, extent, thickness, and value of the mineral deposits are determined. For this purpose the "Diamond Rock Drill" is now being extensively used, both at home and abroad, and the superiority of this method over that of the ordinary shaft sinking is very striking. It bores a perfectly straight, smooth hole to any depth, or in any given direction from the vertical to the horizontal, bringing to the surface in order a solid section or "core" of every stratum passed through, shewing its exact depth, thickness, and the character of the rock. The "core" is large enough to be thoroughly tested, and can therefore be subjected to physical and chemical tests. Another advantage of great value is, that, in the event of the mineral sought for being absent, this important fact is conclusively proved. It also gives positive information of the nature of the strata, thus making it possible to estimate the cost of the shaft closely. Any machine for accomplishing such work must have many requirements. It must be strong, simple, and durable, economical in the use of steam, and in the wear and tear of the diamond or "carbon" points, rapid in operation, and, above all, its work must be accurate and reliable.

Many excellent diamond rock borers are manufactured, but the "Sullivan" machine is the one I more particularly advocate, as it combines all these important and essential features. As regards its construction, with the exception of the smaller sizes, it consists of the engines, the hoisting, and the feed apparatus. Each part is distinct, and can be operated independently of the others. They are mounted on a cast-iron base plate, which rests on a bolted and braced hard-wood frame. The base plate slides backwards and forwards on ways on the frame, moved by a hand lever working in a rack on the frame. The engines are designed

especially for these machines, with a view to completeness and economy. They are vertical, two in number, set quartering, and can be driven by steam or compressed air. The hoisting apparatus in the larger machines consists of an iron drum, wound with wire-rope, and with suitable combinations of gearing for hoisting the full weight of rods from any ordinary depth without the necessity of using double blocks. For the advance or "feed" of the drilling bit the single cylinder hydraulic piston feed is used, except in the case of the "M" and "E" drills.

In purchasing one of these machines it will be well to select one a little larger than that just equal to the work contemplated, in case the drilling should be carried deeper than was expected. The location of the prospect hole should be determined by the extent and general features of the land to be developed. The ground should be reasonably good for hauling, and, where the available supply of water is limited, it might be used over and over, allowing the water as it comes from the hole to run back into the tank or well from which it was pumped. The bit, when it first penetrates the rock, is first set on its lowest face and inner and outer edges with the small pieces of black diamond or carbon. As the bit is rotated and fed forward, the diamonds chip and grind away the rock in an annular hole, leaving untouched in the centre a cylindrical "core." The bit passes down over this "core," followed by the core shell and the core barrel. The latter is a smooth-bored tube, in which the core is enclosed. After drilling as many runs as will fill the core-barrel, the rods are pulled up, until the top joint reaches the surface, disconnected at the joint, and the drill moves back on the frame out of the way. Casing pipe is used to keep the hole clean, and to prevent caving. When its use is found necessary, the hole is enlarged to a suitable diameter by means of a reamer. No core is made in reaming, the object simply being to enlarge the hole. All the indications of the machine and gauges should be closely watched, as well as the cuttings as they come to the surface, as the indications shew before the rock is pulled up the thickness of the strata, and the character of the rock, and they act as checks which establish the accuracy of the work beyond question.

It is undoubtedly well known that Cornwall does not enjoy at the present moment that mining prosperity which so eminently

distinguished her years ago. To the dark cloud, however, there is a silver lining, for we are assured by the highest mining authorities of the day that there is every probability of this highly valued ore of tin, which forms such a valuable and indispensable article of commerce, being found below the workings of the long-since abandoned copper mines of the county. Cornwall is essentially a mining county, and if she is to maintain her position as a tin producer, the mining industry must be fostered in every conceivable way. The Diamond Drill has amply justified its existence in many parts of the globe, rapidly growing in popularity as a means of expeditiously testing for minerals, and I firmly believe that if adopted in Cornwall, and deep borings are made in the abandoned mining districts and in the virgin ground, highly important discoveries of tin will result, and that very many years will roll by ere Cornwall will be pronounced to be tinless

A Year's Weather.

By HENRY CROWTHER, F.R.M.S., Curator of the Truro Museum.

JANUARY.

We have made a good start for a dry year. Our monthly rain, hail, and snow falls, when all calculated, equalled a total downfall of 2·27 inches, the driest January for thirteen years. In my letter on "Weather for December" I showed how the year closed, a little drier than 1890; and, singularly, the Board of Agriculture give the wheat crop of Great Britain at 31·26 bushels an acre, as compared with 30·74 bushels for 1890, which is in near accord with the meteorological observations of that letter. The month was cold, our average maxima of heat for January being 48·27 degrees, last month it was 46·10; our average minima, greatest cold in night, 38·10; last month, 34·00 degrees, or a monthly mean of temperature, two-and-a-quarter degrees colder in the day, and over four degrees colder in the night. The sun shone on 19 days, and we had a peep of the sun behind the clouds on nine other days; yet snow fell on six days, hail on six, and fog was in evidence on four days. Our most prevalent winds were northerly, the next north-westerly. On one day we had the wind in the south; it followed a south-westerly wind, and brought with it the heaviest day's rainfall (·74 inch) of the month. We had rain on 22 days, and frost on 17 days. The highest reading of the barometer was on the 26th, 30·52; the lowest 29·03 inches, on the 16th—a range of 1·49 inches. We often complain of the heaviness of certain days, but few of us fully realize the meaning of the cheerful or depressing effects of the alternating column of air which rests upon us, and is measured by our barometers. Every square inch of this column weighs, when the glass stands at 30 inches, about 15lbs.; over 2,000lbs. to the square foot, and over 30,000,000 tons to the square mile. The range of the barometer between the 16th and 26th of January was 1·49 inches, one-and-a-half inches, and the oscillation of the mercury through such a space means a difference of about 1,500,000 tons per square mile. Such

varying pressures cannot take place without causing effects on our seas, often disastrous ones.

We had several delightful days in January, and on three days towards its end, the temperature out of doors was 52 degrees. Our coldest night was on the 11th, when under cover we registered 19 degrees, or 13 degrees of frost, in the open 15 degrees, or 17 degrees of frost; the wind blew over a carpet of snow which overspread the country, from two to six or seven inches deep.

On the 22nd, Mr. John Burton, of the Old Curiosity Shop, Falmouth, sent me some male flowers of the willow, which he had gathered on the Castle Drive, and which for many years he had noticed as coming out in the first week of February, their early appearance on the dry ground there is interesting. Primroses were to be found in the sheltered valleys about Truro.

I regret to say that Mr. F. H. Davey, who so kindly takes the charge of a rain-guage for me at Ponsanooth, is laid up; hence for the time being, and, I hope sincerely, for the briefest period, his interesting records of Kennal Vale are suspended.

I purpose, as last year, to tabulate the rainfalls from month to month, as I learn that this method has given great satisfaction to many of my readers.

	40 years' mean.	1891.	1892.
January......	4·85-ins	3·40-ins.	2·27-ins.

A peep backwards, January 1792:—8th, ice one inch thick in the course of one night. 12th, snowdrop stem above ground, ice in general two and a half inches thick. 14th, thermometer at 10 a.m. registered 26 degrees. 30th, snowdrops in bloom. Rainfall 2·30 inches.

February 9th, 1892.

FEBRUARY.

There are many who believe that bad seasons repeat themselves, and yet would never expect a repetition of the February weather of last year. That month was the driest February we have on record, this year it was the wettest since 1885. The rainfall for this month was 4·43 inches, which fell on 18 days. Our heaviest day's rainfall was on the 18th, ·93, nearly an inch. The month commenced wet, half an inch of rain on the first day, with hail, yet a general feeling of warmth. Next we had a

fortnight of dry weather, and then followed for nine days all sorts of weather changes, snow, sleet, hail, heavy rains, lightning and thunder, the thermometer registering 12 degrees of frost outside, the snow falling six inches deep. Except on one day the sun was seen in gleam or clearness every day in the month. On five nights the thermometers in shade registered frost. Our greatest heat in day showed a monthly mean of 50·4 degrees, one degree warmer than our 40 years' average.

A peculiarity of the month was the general fixity of the wind. It began with a week or more of north-westerly winds, followed by similar periods of northerly, southwesterly, and easterly winds, with which it closed.

The following are the rainfalls of the month and those of last year and a forty years' mean.

	40 years' mean.	1891.	1892.
January......	4·85-ins.	3·40-ins.	2·27-ins.
February ...	3·38-ins.	0·22-ins.	4·43-ins.
Totals ...	8·23-ins.	3·62-ins.	6·70-ins.

The rainfall for January and February, 1890, was 7·46 inches.

The cold and sometimes biting winds did not wholly keep in check the growth of the larger trees; their blossoms depending on the wind for fertilization were conspicuous during the greater part of the month, and gave a pleasant relief to the general wintry aspect of many trees. But many of our valleys, especially noticable from the railway in those about Lostwithiel, were all of a grey-green tint, due to humble plants which grew on the barer ground, the trunks of the trees, or hung in tufts from nearly every twig.

Whether the lichens be useless, or even harmful, they gave a special charm to our Cornish valleys in February. Some lichens are very useful, as the litmus lichen, Iceland and reindeer moss, for dyes and foods.

The lichens in interest take the first rank, though generally so despised. They are slave makers, who have cultivated a taste for vegetable food which they cannot make themselves. A cross-section of a leafy stem shews within small green bodies, these are green algæ which the lichen creeps upon and captures, and wraps up in threadlike tissue, between which light and air can pass. They are not parasitic in any sense of the word, the algæ cells

cannot escape, they are prisoners, but they thrive under their new conditions; it is a case of mutual interdependence, the algæ receive mineral salts, iron, lime, potash, magnesia, and phosphorus, and give to the lichens carbo-hydrates. This relationship is known as symbiosis, and is a phase in plant life particularly interesting at this season of the year when every exposed stone almost, and every tree attests its success.

The weather in February, 1792—one hundred years ago—was a little colder than with us this year, there were more frosty nights, but not so much snow. By the 8th, the thrushes were in song and the primroses in flower, on the 12th the honeysuckle leaf was out, and that of the gooseberry just ready to expand. The wind went out on east as it has done this year. The rainfall was 2·20 inches.

March 17th, 1892.

MARCH.

The driest March for fifty years. The meteorological aspect shows three distinct periods of dryness from the 1st—8th, 11th—13th, 17th—31st, leaving few days on which rain fell. On one of these, the 15th, we had a gale and a downpour of over half-an-inch of rain following a wet day, yet the whole rainfall for the month was little over one inch—1·07 inches. The last March which was nearly as dry was in 1854, the rainfall being 1·08 inches. Our average March rainfall at Truro is close upon 3 inches; some years we have twice that amount, but records of only one-third the usual supply are very rare. We had wet on two mornings only during the month and on three afternoons; most of the rain fell in the night. The sun was fully visible on 25 days and seen in gleam on 4 others, leaving 2 sunless days. The winds had a tendency for north and north-east, giving a chilly feeling to the air. On the 15th the wind veered westerly, and gained such force that great damage was done to property and trees. We had frost on 17 nights, the coldest in shade being 22 degrees—10 degrees of frost—an exposed thermometer registered on the nights of the 12th and 14th 16 degrees, or 16 degrees of frost. On one of these nights we had hoar frost. We had hail on four days and snow and sleet on two.

The average coldness of nights for the month was 33·5 degrees the mean warmth in shade during the day for the month 47·4

degrees, or an average of 4 degrees colder in the day and 5 degrees colder in the night than our usual March temperature. The following are the average rainfalls for comparison; I include those of Kennal Valley, kindly taken by Mr. F. H. Davey, of Ponsanooth:—

	Average of 40 yrs. rainfall.	1891.	1892.	Kennal Vale 1892.
January......	4·85-ins.	3·40-ins.	2·27-ins.	2·89-ins.
February ...	3·38-ins.	0·22-ins.	4·43-ins.	5·11-ins.
March	2·91-ins.	3.90-ins.	1·07-ins.	1·45-ins.
Totals ...	11·14-ins.	7·52-ins.	7·77-ins.	9·45-ins.

During February and March were witnessed the singular reversal of the meteorological phases of the previous year, although the cold and bitter weather of about the same time of the month as the blizzard visited us last year frightened many people into prognosticating another blizzard with a certainty which was truly alarming. Instead, therefore, of registering a dry February and a wet March, our record runs a wet February and a dry March. I saw the March fly (*Bibio*) on the 1st. It was most delightful to see the growth of flowers at one period of the month; they sprang into sight as if they had been hiding beneath the dry and brown grasses for warmth; in places the primrose, daisy, buttercup, ground ivy, violet, and stitchwort asserted themselves, and the golden gorse filled the lanes with the odour of honey. The bees worked as if wishful to make up for lost time, and the rooks fought, stole each other's nests, gambolled, and filled the air with that melodious cawing which registered Spring. March, 1792—one hundred years ago—10th, ice one inch thick, plenty of flowers in bloom. 30th, wheat looked well, not much sun during the month, wind generally got up towards evening; rainfall, 2 inches.

April 11th, 1892.

APRIL.

The rainfall for April was 1·36 inches, which fell on eleven days; on two only of these days were good showers experienced—on the 20th, when a quarter of an inch, and the 28th, when nearly half-an-inch of rain fell. On the remaining days the rain was so slight as only to bring disappointment to the farmer, who was sadly in want of moisture for his parched land. The

rainfall for the month was an inch and a quarter less than our average April rainfall, the driest April since 1887, when only ·36 inch of rain fell. In 1881 the April rainfall was exactly the same as that of this year, 1·36 inches. In April, 1870, the monthly rainfall was ·18, in 1882 5·98 inches.

The end of the month was very cold: this, perhaps, its most distressing feature. The mean of all the daily maxima was 59·9, six degrees below the average; mean of all the nightly minima 38·2, or nearly thirteen degrees below our April average. This coldness followed a period of great heat. Our highest heat in the sunshine was 91 degrees on the 11th, our warmest in shade 72 degrees on the 7th; our coldest in shade on the 15th, (Good Friday), 24 degrees: our greatest cold in the open, 20 or 12 degrees of frost, on the same night. We had frost on nine nights in the shade, and frost during half the month in the open.

The twelve cloudless days with which April opened, and the summer warmth then experienced, unique for such a period of the year, will always give to April, 1892, a meteorological distinction, even in spite of its later coldness, which did so much damage. It seems singular that the weather should play the same freak with the Easter holidays of this year as it did with those of Whitsuntide last year; then, as at Easter, it held aloft the allurements of beautiful weather to break into storm, rain, and snow when the holidays came. It is only on a weather chart that one can really picture the change, and even then it is hard to grasp that so glorious a fortnight of April summer had a following for nearly a week of wet, frost, snow, hail, and sleet. Yet in this came the birds of spring. What a hard time they must have had! We had a range of about 50 degrees of temperature during the month. The wind was chiefly N. and N.E. Of S.W., the common wind with us, we had very little.

The following are the rainfalls for comparison:—

	40 years' mean.	1891.	1892.
January......	4·85-ins.	3·40-ins.	2·27-ins.
February ...	3·38-ins.	0·22.ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
Totals ...	13·75-ins.	10·00-in.	9·13-ins.

We are drier than last year, although February this year was so wet.

Weather 1792, one hundred years ago:—9th, Keen frost in the morning. 10th, Sycamore, elm, and many forest trees foliating. Bees busily employed, and return heavily loaded. Clear sky. Chimney boards put up and fires extinguished. 11th, Swallows observed by a gentlemen who notices they seldom appear before the 17th, and from that to the 27th April. 14th, Vegetation made wonderful progress. 18th, Cuckoo heard; a continued heavy rain for 48 hours, 3 inches of rain falling. 20th, Keen frost, chimney boards taken down, and fires lighted up. 23rd, Strawberries in bloom and trees in bloom, much injured by frost. 28th, New potatoes in market, 2s. 6d. and 1s. 6d. per lb.; green gooseberries, 10d. per quart. Rainfall for month, 4·8 inches.

The warm days in early April brought out many flowers and many birds, so that our records are early this year. Mr. Earthy heard the chiff-chaff on the 2nd; I saw it on the 3rd, the sandmartin on the 7th. I saw the cuckoo on the 16th; it was heard in song in Cuckoo Bottom, Besore, on the 18th. Mr. Morris gave me the 22nd for the swallow which he saw at Shortlanes-end; they were common at Chacewater a day or two after this. The tortoiseshell butterfly I saw on the third. The lilac was in flower on the 22nd, and the horse-chestnut in leaf on the 26th.

Cuckoos are plentiful this year, and will afford to those who have opportunities better scope for learning the habits of these birds than usual. Briefly, for in a letter of this kind one cannot write the history of such a bird, I will state a few facts which are known about the cuckoo. The birds do not mate; only the male birds sing, usually from a tree. Mr. Chirgwin gives me an instance where he heard near Allet Chapel, on the Perranporth-road, three singing at one time, on one tree. When the female birds pass the male birds make a rapid descent and chase them, returning to the same tree usually, and again calling out. The female cuckoo does not make a nest of its own; it lays its egg on the ground—it only lays an egg now and then—and, taking the egg in its mouth, places it in the nest of another bird. Many birds are chosen to rear the young cuckoo, but it has a preference for the hedge sparrow and the meadow pipit. The cuckoo does not suck

other birds' eggs to make its voice clear, but lives on caterpillars, usually the hairy ones, and insects. Another peculiarity worth mentioning is that as soon as the cuckoo is born it begins to lift out of the nest all that is foreign to itself—eggs, foster brothers, and foster sisters. As it gets older this propensity passes off, but then, alas! it has got rid of all who were in the nest with it.

May 12th, 1892.

MAY.

The driest May since 1887; the whole of the rainfall for the month was little over 1½ inches, 1·55 inches, but fortunately the winds have been light; the wind in many cases dries the land more than sunshine. Our average May rainfall here is 2·45 inches, hence the fall of rain this May was nearly one inch below the monthly average. Taking the rainfalls for over forty years the wettest May was in 1869 with 5·42 inches, and the driest in 1876 with 0·13 inch of rain.

The greatest heat in shade during the month was 75 on the 13th; the lowest 29 on the 8th, or a difference of 46 degrees. The barometer stood 30·39 inches on the 12th, and 29·69 inches on the 3rd, a difference of ·70, or nearly three-quarters of an inch.

A glance at the comparative rainfalls shows how favourable the year has been as regards wetness:—

	40 years' mean.	1891.	1892.
January	4·85-ins.	3·40-ins.	2·27-ins.
February	3·38-ins.	0·22-ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
Totals	16·20-ins	12·26-ins.	10·68-ins.

We have had 1½ inches less rain these last five months than the same period last year, and five inches and a half less than a 40 years' mean. This is the period when the rhyme runs in our heads—

"If the ash before the oak,
Then you may expect a soak;
If the oak before the ash,
Then 'twill only be a splash."

So far as I can judge, the oak and the ash simultaneously broke into leaf here at the beginning of May. A comparison of hundreds of the trees, at dozens of places, gave the best foliage first to the oak and then to the ash. Perhaps observers in other localities may decide for me.

On May 17th we had slight evidence of the earthquake which visited Cornwall; its rumbling was heard by Dr. Sharp, at Truro, at 1.30 a.m., and he gave me another case where it was heard near the city about the same hour. My only personal evidence is the knocking down of a series of Cornish birds from their stands in the museum. The line of fallen birds ran north and south, and on naming this fact, the doctor tells me, the report was heard to die out in a similar direction in the Helston district, where the shock was most intense.

I am told that not only have three cuckoos been seen on trees hereabouts, each calling, as mentioned in my last letter, at the same time, but that at Cuckoo Bottom, near Truro, it is no unusual thing to hear three of these birds calling at once from the telegraph wires. Mr. Blenkinsop gives me the 26th, as the earliest date for hearing the landrail in this district, which is late. I saw the swift at Truro on the 3rd. I have had several communications respecting observations in my last weather letter, which, I think, should be mentioned here,and as these weather letters are intended to be familiar and chatty monthly records, observations from other sources embodied in them make them doubly valuable.

The Rev. C. F. Rogers, Sithney Vicarage, Helston, says, "I observed several swallows on the sea coast between Porthleven and the Loe Bar on Thursday April 14th." Our first arrival at Truro was the 22nd. Mr. Wilkinson, Rivière, Hayle, says, "My experience of the weather at the beginning of April was very different from yours at Truro. Of the first twelve days nine of them were accompanied by cold winds, and only three were comfortably warm." I have had a similar experience myself on the north and south coasts this month. Mr. Wilkinson also gives the swallow's first appearance as March 22nd, one month earlier then ours. On March 23rd he again saw, in the presence of two of his neighbours, three more of these birds. This record is exceptionally early.

The Rev. Fred. E. Gutteres, Nymet Rowland Rectory, Lapford, North Devon, gives me the sandmartin's first appearance as March 19th; mine was April 7th. The latter date agrees with its first appearance in the North of England. Mr. Gutteres, in the presence of a friend, saw three of them above the Taw, later in the afternoon they saw four, and then did not see the bird again for three weeks. From the 14th to the 20th of April is the usual time to notice their earliest arrival in North Devon, but this gentleman tells me that he saw his first martin in 1886 at the same spot as this year on March 26th. This early appearance and disappearance of these birds have led many to think that they hybernate. Such a thing is impossible; and, in addition, birds feeding on insects require an almost constant supply of food; to meet this demand, when insects are scarce they try new localities, disappearing for a time from where first seen.

One word about the plants. The hawthorn this year is unusually prolific in flower, not only with us but in many other places where I have seen it, from the Lizard up to Newquay. In some cases not a trace of leaf scarcely to be seen. May I call this the hawthorn year, and does it mean a dry hot summer?

Weather for May 1792 (100 years ago),—2nd, ground strewed with leaves and bloom by the hail-storms; 4th and 5th, keen morning frosts; 12th, ice in the morning, early potatoes injured; 16th, hawthorn in bloom; 19th, laburnum and honeysuckle in bloom; 21st, landrail heard. The air of the month is generally raw and cold. A show of fruit, but much injured by weather. Cattle that lie out seemed starved, some have been sick, occasioned as supposed by cold. Milch cows fail in milk. Fall of rain 3·40 inches.

June 25th, 1892.

JUNE.

With a rainfall of 1·83 inches, June was comparatively dry; last year we had one inch more rain during the month than this. The rain fell on eleven days, but except on three of these, the rainfall was very slight. The heaviest day's rain was on the 1st, with eight-tenths of an inch; and, singularly, last year, on the 1st of June, we had one inch of rain. It was a month of sunshine. The sun was visible on every day except one. Day after day

we registered in the sunshine temperatures from 96 to 104 degrees. Whitsuntide fell this year amidst this display of heat. A wet Saturday was followed by a beautiful Whit-Sunday and a scorching hot Whit-Monday. I spent the day in company with friends dredging in Helford River, and we enjoyed the warmth very much.

June this year was not exceptionally dry for Truro—we have had many drier. Of those of the last 40 years 15 have had a less rainfall, the driest being that of June 1887, with only ·05 inch; next, June 1859, 0·26, about a quarter of an inch, whilst the June of 1870 was almost as dry with ·32 inch; the wettest June we have any record of during the above period was June 1860, 7·38 inches of rain.

The comparative rainfalls are:—

	40 year's mean.	1891.	1892.
January	4·85-ins.	3·40-ins.	2·27-ins.
February	3·38-ins.	0·22-ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
Total	18·59-ins.	15·12-ins.	12·51-ins.

The rainfall of the last six months in Kennal Vale, taken by Mr. Davey, is nearly three inches heavier than ours:—

January	2·89	inches.
February	5·11	"
March	1·46	"
April	1·32	"
May	1·72	"
June	2·85	"
	15·35	"

A glance shows we have had a very dry six months; we are six inches under our mean rainfall, and nearly 2½ inches drier than the first six months of last year.

The glass kept very high, close on 30 inches, during the whole month; the winds were chiefly south-easterly. The average heat in shade was 67·5 degrees, the average coldness of nights 48·9 degrees; we had no registration of frost; our highest temperature in shade during the day was 78 degrees on the 28th, the thermometer in the sun registering 104 degrees.

Our coldest night, under cover, *i.e.* the glass was not exposed, was 39 degrees, on the 18th, so that during the month the temperature in shade ranged 39 degrees. June is the month when nature looks its brightest, and this year it has been no exception to the rule. The foxglove showed up well this season, and the growth on the younger trees was very distinct, the cereals wheat, barley, and oats looked very healthy. I was very much struck with the butterfly life; I never saw so much of it, my observations extending from the Lizard up to Newquay. The meadow browns, blues, and coppers were very common, and the bigger and brighter ones, such as the Peacock, Tortoiseshell, Red Admiral, and even the Painted Lady were not rare. On two occasions I saw the Clouded Yellow, *Colias edusa*, Fabr. and as much discussion arises on the distribution of this form, which only appears to turn up in certain years, I make the record here, as verified by another witness, who is a naturalist; St. Clement's, Truro, June 2nd; and at Cadgwith, the Lizard, on the 3rd, next day; I saw it both times on our lovely Cornish hedgerows.

Weather in June, 1792—100 years ago.—5th, bees swarm; a field of grass mown for hay. 17th, thunder and lightning. 18th, Fox-glove in bloom. 20th, very little sun; hay harvest protracted; none spoiled; the crops heavy upon the high and rich lands; pastures in general abundant, but the grass sour; spring corn appears starved; wheat and early oats in the ear. Fall of rain this month, one inch.

July 20th, 1892.

JULY.

The month was dry. Rain fell on 14 days, but on only six of these had we proper showers. Total fall 1·76 inches. Though so dry, July last year was drier, with a rainfall of 1·62 inches. This July was a hot month, with plenty of sunshine. There was not a single day on which the sun was not visible. We had thunderstorms on the 11th and 13th.

The following are the seven monthly rainfalls:—

	40 years' mean.	1891.	1892.
January......	4.85-ins.	3·40-ins.	2·27-ins.
February ...	3·38-ins.	0·22-ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1.07-ins.

April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
July	2·50-ins.	1·62-ins.	1·76-ins.
Total ...	21·19-ins.	16·74-ins.	14·27-ins.

A glance shews how it is that we are enjoying the distinction this year of being one of the most favoured counties as regards weather. I receive many letters from correspondents asking if Cornwall is under sunshine and suitable to visit, and this year my replies have invariably been "Weather glorious!" A rainfall for the seven months seven inches below the mean rainfall, and only two-thirds the usual downpour, must give dryness.

This dryness has been favourable to the potato and to the corn, as these crops have not felt so much the ill-effects of moulds, smuts, and rusts as they do in warm, wet weather. How little is popularly known about these enemies, and yet how interesting their history to the scientific mind. When one thinks that the smallest wrinkle in a potato leaf holding a drop of rain or dew is a lake, comparatively, for the development of any potato-disease spores which may fall into it, one feels glad to record a July free from mugginess, *i.e.*, warm, steamy wetness. A potato-disease spore falling into such a drop of warm rain, small though the spore be, breaks up into a score or two of minute swimming spores, each bent on boring, by means of little rootlets, into the potato leaf, and stealing the starch ready in the leaf to be passed into the tuber. Once in possession, leaf, stem and tuber fall before their poisonous attack.

Generally the barometer stood high during the greater part of the month, yet it had a range of over eight-tenths of an inch.

The highest heat in shade was on the 30th, temperature 80 degrees; the lowest 42 degrees, on the night of the 23rd; a range of 38 degrees.

The wind had about as many records from the north and east, as from the south and west, the latter bringing us the rain mentioned.

From correspondents I find that my observation about the appearance of the Clouded Yellow butterfly ***Colias edusa***, Fabr., in the last month's weather letter is confirmed. Records of its occurrence in addition to my own at Truro and The Lizard, are to hand from Perran, Lostwithiel, Par, Worcester, and Essex.

Just another nature note: Robins are plentiful this year. Watch them. A sudden dart from the meadow into the hedge; on reaching a twig they suddenly turn, presenting to the observer their red breasts, and then remain perfectly still—as if stuffed—often ten minutes or so. We are just on the turn of the year, the black fungus is on the sycamore already, leaves are turning reddish, and the robins are becoming hard to distinguish in their surroundings.

A peep backwards, about which many of my readers like to read, July, 1792—100 years ago—17th. A hail storm, preceded by continued thunder for more than half an hour, as if it came from different points; sometime before and during the storm, which did not continue a couple of minutes, pitchy darkness; and during the fall of hail a violent gust of wind. Hail stones about two inches long, angular and pointed, as if encircled with ice; the storm was followed by long and heavy rain. Vegetables injured. Some fields of wheat so much injured that they were mown for fodder for cattle. Chiefly gloomy weather the whole month, very little sun, many days without the least appearance, hay harvest far from being finished. Rainfall 2·3 inches.

What a contrast between July 1792, and July 1892!

August 22nd, 1892.

AUGUST.

For over three-fourths of the month we had splendid harvest weather, with every prospect of registering a very dry August. Up to the 23rd only 0·67 of an inch of rain had fallen, the days followed one another beautifully fine, plenty of hot sunshine, though cold on some nights. On the 17th we had a magnificent day, 102 degrees in the sun; then a little dulness and yet a tendency to be fair. The first serious break was about 4.30 p.m. on the 24th, when we had a heavy sudden shower; yet next day, which I spent on the Gwithian and Godrevy Towans and along the North cliffs, was delightfully fine. On the Friday, the day still kept fair with plenty of sunshine, but after midnight the rain came down in torrents, next morning we registered nearly half an inch; the downpour continued all Saturday, the rain gauge giving next morning 1·90 inches, nearly two inches of rain for the 24 hours.

Some observers got more than this, as did Mr. Daubuz at Killiow, and further west of the same district, but equally well wooded, Mr. Davey, in Kennal Vale, registered 2·26 inches. The wet continued till the month was out, registering 3.55 inches in six days at Truro, and 4·84 inches of rain in Kennal Vale. Our total downpour for the month was 4·40 inches, which, though making this August a wet month, is much less than last year, when the rainfall was 6·48, or over two inches more rain. August last year was one of the wettest on record. It is singular that the next heaviest records of rain occur in four consecutive years—1876, 4·37; 1877, 5·84; 1878, 4·49; and 1879, 5·33 inches. Since then, till last year, the Augusts have been comparatively dry. Our average August rainfall is 3·01 inches.

The following are comparative rainfalls:—

	40 years' mean.	1891.	1892.
January......	4·85-ins.	3·40-ins.	2·27-ins.
February ...	3·38-ins.	0·22-ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
July	2·60-ins.	1·62-ins.	1·76-ins.
August	3·01-ins.	6·48-ins.	4·40-ins.
Total ...	24·20-ins.	23·22-ins.	18·67-ins.

These show over four and-a-half inches less rain in this district from January to August than last year, during the same period. To the visitor Cornwall never, perhaps, appeared more charming than during this month, but the bright sunshine and continued blue skies brought on droughts in many villages, and many were at their wits' end for water when the welcome rain came. The contour of the county allows of plenty of rainfall without much injury.

The usual height of the barometer was not quite reached, the mean pressure in August with us is 29·989 inches, this month 29·936 inches. The temperature of the month was favourable; the average mean of our highest temperature in shade is 69·70 degrees, this August it was 69·80 degrees. Our average greatest coldness of nights in August is 54·21 degrees, this month it was

53·80 degrees, or a little warmer in the days and a little colder in the nights than usual in August month.

On three days during the month the sun was not visible, the winds were moderate except on the 14th and at the close of the month.

The excursion of the Royal Institution of Cornwall to Dolcoath and Tehidy was made amidst this wind and rain; few will forget how they met those who were journeying over the hill near to Redruth. Our rainfall during the excursion this year was not continuous, the total rainfall being 0·30 inch, or under one-third of an inch; last year, when the excursion was to Padstow and Prideaux Place, the downpour was 1·48 inches, nearly one and a-half inches of rain, about five times as heavy as on this year's outing.

Just after midnight on the morning of the 18th, earthquake shocks were felt throughout Cornwall. Perhaps an epitome, without any explanation of the causes of earthquakes, would be read with interest. Direction: south to north. Duration of shock: probably from three to thirty seconds. Effects: a general awakening of people, rattling of windows, doors, and crockery, shaking of houses, and earth tremors. The following are a few Cornish impressions:—"Sharp shock" (Penzance); "Perceptible shake of the earth" (Redruth); "Perceptible motion of the earth, bed seemed to be lifted from the floor, watch was thrown down and glass smashed" (Truro); "Furniture was in a state of perturbation" (St. (Blazey); "Noise resembled that of a rumbling waggon" (Lostwithiel); "Noise of falling bricks, a low rumbling sound" (Helland); "Curious trembling of houses without any noise" (Callington); "Walls vibrated, and china and other articles distinctly rattled" (St. Cleer); "Loud noise somewhat resembling the sound of thunder" (Liskeard); "Slates on the roof rattled" (Tregeare, near Launceston); many in Truro say they felt the shock, personally, I was totally oblivious.

Further records of the occurence of the Clouded Yellow butterfly *Colias edusa*, Fabr., in many localities have been sent me, and Mr. Davey saw in Kennal Vale as pecimen of the Pale Clouded Yellow, *Colias hyale, L.* Although we have had so exceptional a summer for butterflies—and these insects have been very common, too—yet the dense flights of the Clouded Yellow, so frequent in 1877, have not been observed.

Councillor Buck noticed at Perran a remarkable swarm of one of the cockchafers, *Rhizotrogus solstitialis, L.*, which almost covered the outsides of some of the houses. The farmer should see that all cockchafers are destroyed, as the beetle both in the grub and perfect state is harmful to vegetation.

Weather in August, 1792—one hundred years ago—3rd, fall of rain in the night, ·20 of an inch; corn lodged much in consequence of the rain. 11th, wheat and barley have changed wonderfully in colour in a few days. 17th, butterflies busy amongst the cabbages depositing their spawn. 18th, pears ripe and abundant. 23rd, oats cut. 26th, fall of rain yesterday, and the present 1·80 inches; grain of all kinds laid quite flat by the last fall of rain. 30th, wheat cut; harvest becoming general; fall of rain this month, 5·20 inches.

The rainfall of August one hundred years ago was heavy, and its greatest showers were on the 25th and 26th: ours, on the 26th and 27th. On the 26th of August, 1792, it rained all day, but ceased at 7 p.m., on the 27th of August, 1892, it rained all day.

September 20th, 1892.

SEPTEMBER.

We have had only about eight Septembers during the last 43 years so dry as the last one. Our average rainfall for the month is three and a half inches, but last month under two inches fell during that period. We had wet on 16 days, which singularly is the average number of days on which rain falls in September here, but half of them only registered one-hundredth of an inch each, or under one-tenth of an inch for the eight days. We had a dribbling rain about the 7th and 8th, a heavy shower on the 20th, rain which fell somewhat heavily on the 27th, a little lighter, but continuous on the 28th, which finished in very heavy rains on the 29th, with these exceptions we had practically a dry month. Mr. Davey gives me the September rainfall in Kennal Vale at 2·88 inches, an inch heavier than at Truro.

September, 1891, was a sad month to the farmer, but September this year was more favourable as regards rain, as the downpour was less by 1.13 inches. We saw the sun on 28 days. The month suffered from coldness. We did register on one day 70 degress in shade, but registrations of 75, 76, 77, 78, 79, 81, and 82 degrees

are not uncommon here during this month, and our average September heat in day runs 3 or 4 degrees warmer. We were colder by 1 degree at nights, so that on one or two nights frost was felt. On the evening of the 18th we had 2 degrees of frost in shade and 5 degrees in the open, the range of temperature on that day being 38 degrees.

The following are the comparative rainfalls:—

	40 years' mean.	1891.	1892.
January	4·85-ins.	3·40-ins.	2·27-ins.
February	3·38-ins.	0·22-ins.	4.43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2 48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
July	2·60-ins.	1·62-ins.	1·76-ins.
August	3·01-ins.	6·48-ins.	4·40-ins.
September	3·49-ins.	3 03-ins.	1·90-ins.
Total	27·69-ins.	26·25-ins.	20 57-ins.

A glance shows how favourable we are as regards rain this year, our year's rain so far being slightly over five inches and five-eights less than last year during the same period.

The cold weather has stopped the flight of butterflies, but their great number and variety this year will be long remembered by many observers. It will be recollected, too, as a year when the Clouded Yellow was plentiful, though not so numerous as in 1877, many correspondents have seen it so common as to be particularly attracted by it. The foliage of the trees, except the sycamore, and plane, is still holding on, and does not show any abnormal appearances. The ruddy glow of the hawthorn berries is one of the prettiest sights this autumn in our lanes, and later on when the leaves have gone they will be more noticed. We have many flowers still in the hedgerows.

In September, 1792—one hundred years ago—the price of wheat in Cornwall was 5s. 8d. per bushel.

Weather:—4th, people very busy at harvest work. 7th, cutting second crop of clover. 10th, a strong gale of wind, attended with violent storms of rain and hail; corn considerably damaged. 12th, fall of rain, nearly one inch. 14th, swallows sporting on the wind in flocks. 18th, furze in autumnal bloom.

20th, a loud and long clap of thunder about 10 o'clock at night. 21st, two claps of thunder about half-past two p.m. 23rd, Rain-gauge quite full, 5½ inches deep. 26th, the sun of this day, which was brilliant, a welcome guest, and so great a stranger that every countenance seemed cheered by his friendly and benign aspect. 29th, the rain of yesterday, accompanied by close and sultry air, has contributed more to injure the grain than any of the preceding weather. Wall fruit has little flavour. Apples fall off and are insipid. The greatest part of the grain remains in the field. Summer fallows in sad plight. The leaves of the turnip turn yellow. Fall of rain 7·8 inches. Only four days during the month on which it did not rain.

Surely we have need to rejoice in comparison to our ancestors of one hundred years ago with a September rainfall nearly six inches in excess of our experience for the same month this year.

October 26th, 1892.

OCTOBER.

A glance down the weather sheet shews a repetition of cloud character of a somewhat ominous nature, for the word nimbus—rain cloud—occurs with much frequency, for three weeks out of the four we had constant records of this class of cloud, and rain fell on 22 days. The month came in very wet, ·85 of an inch of rain, the second day being also wet, the two days giving one hundred and twenty tons of rain to the acre; on the 6th and 7th, we had nearly one hundred tons, and between the 24th and 27th nearly two hundred tons of rain over a similar area. Our total downpour for the month was 5·70 inches, which is in excess of Mr. Davey's record for Kennal Vale (4·34) by 1·36 inches, about one inch and one third.

Heavy as the rain seemed, it was only about two-thirds of the rainfall of October last year. We often have heavy October rainfalls of 6 or 7 inches, and in 1865 we had one with over 9 inches of rain. Our average rainfall for the month is 4·80 inches.

In addition October was cold. We had frost on eleven nights under cover, and on some of these nights it registered on the exposed thermometers 7 degrees of frost. As a rule at such times there is apt to be great ranges of daily temperature, which do great

damage to vegetation. On one day (30th), we had such a range, when the maximum and minimum thermometers in the same screen stood 26 degrees apart, and on the 13th and 19th, 25 degrees.

The mean temperature of the air for the month was 49·4 degrees, and the average height of the barometer was 29·691 inches. The range of the barometer during the month was 1·05 inches. Our warmest day in shade was the 6th, 61 degrees; our coldest night in shade was the 19th, 27 degrees, the difference of 34 degrees being the range of temperature for the month. The winds were for two-thirds of the month from north-east, and for one-fifth south-west. We had hail on the 1st, 2nd, 15th, and 21st.

There are two nature phenomena of interest at this season, the changing foliage and the falling leaves. As one looks down some winding coombe the tinted leaves seem the most striking of the two: they touch more our love of the beautiful. How few of us feel any compassion for the plane or the sycamore which has shed in a single night nearly the whole of its foliage before a biting wind. The leaves have every appearance of being burned, and rustle before the wind on the hardened road, as if they were fresh from a fire. Yet the tree forsaw all this and prepared for it, the leaves could not have fallen otherwise in that great mass beneath the branches of the tree. When once we realize that, as a rule, every leaf is cut off by the parent, and that, too, very soon after the leaf has attained its full growth preparation is being made for its separation by the ingrowth of a thin layer of cork-like tissue at the base of the leaf stalk, the fall of the leaf becomes an intensely interesting study, surpassing, to many, even the study of the tinting of the autumn leaves. Of course, some trees, as the oak, beech, and others do not shake off their leaves so readily, and some, as the evergreens, are out of season, yet so many trees obey the common law that the bareness of winter is understood to apply to this phenomenon. Add to this, and it clearly belongs to it, the action of gravitation, and watch its effects on the falling leaf; those effects give the flutter to the leaf. But this is a study beyond a weather letter, yet ever interesting to the observer.

Below are the rainfalls for comparison:—

	40 years' mean.	1891.	1892.
January......	4·85.ins.	3·40-ins.	2·27-ins.
February ...	3·33-ins.	0·22-ins.	4·43-ins.

March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
July	2·60-ins.	1·62-ins.	1·76-ins.
August	3·01-ins.	6·48-ins.	4·40-ins.
September	3·49-ins.	3·03-ins.	1·90-ins.
October	4·81-ins.	8·55-ins.	5·70-ins.
Total	32·50-ins.	34·80-ins.	26·27-ins.

We are 8½ inches drier than last year for the same months, and 6½ inches below the average.

Weather for October, 1792—one hundred years ago:—12th, gathered the orange pippin apple, whilst on the eastern aspect of the tree was a considerable quantity of bloom; the fruit has very little flavour. 14th, severe lightning. 15th, thunder and lightning. 24th, hoar frost and some little ice; many potatoes yet remain in the ground, which have received no inconsiderable damage, numbers being quite rotted; very little wheat yet sown; carrots of a large size in general, the following are the dimensions of a particular one on common ground:—Length, 19 inches; circumference, 16 inches; weight, 4½ lbs. avoirdupois. Springs have never failed, but kept continually running; the trees begin to be despoiled of their foliage; leaves of the hawthorn quite gone. Fall of rain this month, 5½ inches.

November 22nd, 1892,

NOVEMBER.

Our average November rainfall for forty years is 4·37 inches: the average of the last ten years, 4·83 inches; this month it has only reached 3·11, about 1¼ inches less than usual. It is the driest November since 1884, and is one of the six driest Novembers for over forty years. During the same month in 1852 it rained 10·51, and in 1888, 8·89 inches.

The chief winds have been N.E. and S.W. Taking the cloud, and considering 10 to represent a sky entirely covered with cloud, and 0 to shew a cloudless sky, the average cloudiness of the month was 5·6.

It was a warm November; certainly we had frost on four nights under cover, and on one of these nights an exposed

thermometer registered seven degrees of frost, yet the mean temperature was somewhat high. The thermometers read 60 degrees on two or three days in the shade; so that taking the mean of the daily monthly heat and the nightly monthly cold the mean temperature for the month was 48·5 degrees The range of temperature was 14·7 degrees. The barometer stood its highest on the 28th, 30·50 and its lowest on the 6th, 29·50 inches, a monthly range of one inch. We had fog on the 10th and 24th. The rain fell on 19 days, the chief downpours being on the 4th, 18th, and 25th, when 1·84 of the month's rainfall of 3·11 inches was registered Mr. Davey gives me the rainfall at Ponsanooth as 1·17 inches, so that in Kennal Vale the month has been somewhat dry.

The following are the comparative rainfalls:—

	40 years' mean.	1892.	1892.
January......	4·85-ins.	3·40-ins.	2·27-ins.
February ...	3·38-ins.	0·22-ins.	4·43-ins.
March	2·91-ins.	3·90-ins.	1·07-ins.
April	2·61-ins.	2·48-ins.	1·36-ins.
May	2·45-ins.	2·26-ins.	1·55-ins.
June	2·39-ins.	2·86-ins.	1·83-ins.
July	2·60-ins.	1·62-ins.	1·76-ins.
August	3·01-ins.	6·18-ins.	4·40-ins.
September..	3·49-ins.	3·03-ins.	1·90-ins.
October......	4·81-ins.	8·55-ins.	5·70-ins.
November...	4·37-ins.	5·03-ins.	3·11-ins.
Total ...	36·87-ins.	39·53-ins.	29·38-ins.

We are over 10 inches drier for the eleven months of this year than for the same period of last year. and 7½ below the mean rainfall of forty years.

Mr. Morris, of Truro, gave me a record of a Garden White butterfly late in November. It was a sign of the mild season. The appearance, often in noticeable numbers, of certain of our common butterflies in late autumn is worth a passing word. The geologist regards such a form of butterfly as a living type, speaking to him, like an erratic or an ice-scratched boulder, of the Ice Age, when nearly the whole of Europe lay under glacial ice. A Garden White butterfly hatched in autumn—not a hybernating summer specimen—differs in colour from what it

would do if born in spring. The effect of varying temperatures on clusters of eggs of butterflies may produce two distinct forms, one with the white wings blackened at the base, the other blackened at the tips; one of these is the type form, the other a distinct variety. During the glacial period the short cold summers allowed of only single-brooded butterflies, but the increased heat and longer days have permitted in some cases of another brood—and in other cases of two more broods—arising from the same insects during the year, giving rise to the dimorphic and trimorphic insects of the biologist.

Weather for November, 1792,—one hundred years ago:—3rd, primroses in bloom. 12th, flocks of fieldfares pasturing on the land; late crops of barley housed to-day. 15th, a violent storm of wind and hail. 16th, Seagulls in abundance *inland.* This month was gloomy; colds under the fashionable term of influenza have prevailed very generally both the last and present month. Fall of rain, 1·20 inches.

A hundred years ago November was even drier than our somewhat dry November this year.

December 22nd, 1892.

DECEMBER.

The rain fell on 19 days, reaching a total of 2·52 inches, the driest December since 1885, when the fall of rain was 2·17 inches. Our average rain in the last month of the year is 4·65 inches, so that we were more than two inches below our average, which is a mean of over 40 December rainfalls. Taking the same month during this long period, the wettest December was in 1876 with 10·59 inches, and the driest one in 1873 with 1·23 inches of rain.

The month was cold. Just after Christmas we had intensely severe weather, hoar frosts came day after day and the thermometers sank very low before them. Taking outside temperatures from the 26th to the 30th, we registered 18, 11, 13, 23, and 28 degrees respectively; the registration of 11 degrees on the 27th, marked the coldest night of the year, with 21 degrees of frost; the second coldest was the next night with

19 degrees of frost, and the third coldest nights were on January 10th and 11th, (1892), with 17 degrees of frost. Many may remember those nights; we had several days of frost and heavy hail, then snow fell heavily, covering the ground some five or six inches, the north winds blew over this carpet giving a chilliness, before which the exposed thermometers sank 15 degrees. The intensity of the December frosts may, perhaps, be better realized when we observe that their registration was 4 degrees below the keenest of the January colds, even with the help of a covering of snow to blow over.

Yet there were some delightful days in December, two were simply glorious, the rooks sported and tumbled in its brightness as if it were spring, and the bright sunshine and intense blue sky were most enjoyable.

We had hoar frost on eight days, hail on four, and a flake or two of snow on one night. The winds were chiefly S.W. and N.E., the one bringing us rain, the other frost. The mean amount of cloud was 5·6, taking 10 as a maximum. The range of temperature of the thermometers in shade, 39 degrees. The mean temperature of month 43·7 degrees. Mean height of barometer 29·945 inches, being its highest on the 17th, 30·47, and lowest on the 5th, 29·45, or a range for the month of 1·02 inches.

The following are the summaries of rainfalls for comparison:

	40 years' mean. Inches.	1891. Inches.	1892. Inches.	Greatest Fall in 24 hours. Inches.	Date.
January	4·85	3·40	2·27	·74	16
February	3·38	0·22	4·43	·93	18
March	2·91	3·90	1·07	·53	15
April	2·61	2·48	1·36	·43	28
May	2·45	2·26	1·55	·54	26
June	2·39	2·86	1·83	·80	1
July	2·60	1·62	1·76	·66	15
August	3·01	6·48	4·40	1·90	27
September	3·49	3·03	1·90	·63	26
October	4·81	8·55	5·70	·94	26
November	4·37	5·03	3·11	·76	18
December	4·65	5·22	2·52	·37	1
Total	41·52	45·05	31·90		

A glance shews how dry the weather has been, we are 13 inches or a little over 1,300 tons of rain to the acre less than last year, and over 9½ less than our mean yearly rainfall. Mr. Opie, of St. Agnes, whose measurements of the rain are given below, says the rainfall of 1892 is 7·81 inches below an average of 25 years, in his district. The records from Kennal Vale, taken by Mr. F. H. Davey, of Ponsanooth, shew a decrease of nearly 13¼ inches on last year's fall. The deficiency of rainfall in the South-West district of England for 1892 amounts to 10·8 inches, or more than 25 per cent. below the average of the 25 years, 1866-90.

The rainfalls of Kennal Vale and St. Agnes, taken by Messrs. Davey and Opie, I append:—

	Kennal Vale.		St. Agnes.	
	1891. Inches.	1892. Inches.	1891. Inches.	1892. Inches.
January	3·23	2·89	2·37	2·83
February......	·10	5·11	·14	3·95
March	3·25	1·46	3·47	·85
April	2·35	1·32	2·22	1·50
May	3·37	1·72	2·15	2·00
June	2·93	1·85	2·58	1·66
July	1·89	2·57	1·95	1·63
August	7·34	5·53	6·04	4·17
September ...	3·22	2·83	3·95	3·27
October	10·26	4·34	8·41	4·78
November ...	6·15	4·17	4·51	3·85
December ...	6·70	3·29	4·74	2·58
Total ...	50·79	37·08	42·53	33·07

The wettest day of the year and the amount of rain which fell in the three districts may be interesting to many:—Truro, August 27th, 1·90; St. Agnes, August 27th, 1·43; and Kennal Vale, August 27th, 2·26 inches.

Weather for December, 1792—100 years ago. 4th, storm in the evening. 5th, great quantities of seagulls inland; three different rainbows in the space of one hour; a hurricane from N.W. began soon after one, accompanied by rain, and continued for twelve hours; during the storm the barometer sank over one inch. 8th, a fiery horizon, with stripes of black; the sea roars in the evening. 12th, the wind still blowing a hurricane;

this and several evenings since the 8th, with some intermission during daylight. 21st, a large circle, or as is vulgarly termed, wheel round the moon; rain generally succeeds. 22nd, a violent storm of wind, accompanied with rain, began about three p.m., and continued almost the whole night; fall of rain 6·6 inches.

Rather a rough and wet December in 1792; as the rainfall for the year was 43·80 inches, they had a wet year, too, our ancestors of 100 years ago.

January 18th, 1893.

Obituary Notice.

The name of our late Vice-President, Dr. JAGO, has been so intimately associated with the history and progress of the Royal Institution of Cornwall during the last forty years or more, that it becomes naturally our duty to place on record in the Journal of the Institution, a few brief notes on his personal and scientific career. It has fallen to the lot of few scientific men to be able to give, for so long a period, so much active assistance in the management of a Society as he did, for it is well-known that Dr. Jago has never failed in taking a more than common interest in everything that had for its object the prosperity of our Institution. Next to his venerated friend, Dr. Barham, perhaps, no one was more devoted than he in promoting its scientific and general welfare, whether at the Council table, the Annual Meetings, or at the more social summer excursions. He had filled with distinction the offices of Secretary and President, and at the time of his death he was our oldest Vice-President. The Institution has sustained a great loss by the removal of so old a supporter of its interests, while his many friends most deeply deplore that they have been deprived of a faithful colleague, although during the last few years his physical weakness quite incapacitated him from attending the ordinary meetings.

JAMES JAGO, B.A. (Cantab), and M.D. (Oxon), F.R.S., was the second son of Mr. John Jago, of Falmouth, who married Jane, daughter of Mr. John Smith, of Tregearn, St. Keverne. He was born on December 18, 1815, at the Barton of Kigilliack, Budock, once a seat of the Bishops of Exeter. This branch of the family formerly resided in the parish of St. Erme, where they were settled before the year 1588. In 1646, a Mr. John Jago, of Truthan, from whom Dr. Jago was lineally descended, petitioned the House of Lords respecting some land held by him under Col. Nicholas Burlace. In his petition he complains "that the said Nicholas Burlace had turned him out of certain lands which he held under him, and he prays that he may be permitted

to repurchase the land, etc., on which his ancestors lived for 300 years." (*Calendar of MSS.*, *House of Lords*). Dr. Jago always referred to this John Jago with a considerable family interest, as he was considered to have been of some note in his day as a strict Parliamentarian. He was appointed a Commissioner of Sequestration by Oliver Cromwell, and died at Truthan in 1652.

When young Jago was in his eighth year, his father went to reside at Falmouth, which gave him many advantages. Though of such tender years, the youth was sent to the Falmouth classical and mathematical school, where he received his preparatory education. He remained a pupil in this school until about 1833, but as it was the intention of his father to send him to Cambridge, he had afterwards the advantage of receiving some advanced lessons in classics and mathematics from private tutors. Dr. Jago retained an interest in the Falmouth school to the end of his life.

In 1835, Dr. Jago entered St. John's College, Cambridge, as a pensioner, from which he graduated B.A. in the mathematical tripos of 1839 as 32nd wrangler. Soon after he completed his course at Cambridge, he resolved to adopt the medical profession as his future occupation of life. For this purpose, and to obtain the necessary qualifications, he studied at various hospitals in London, Dublin, and Paris. But anxious to have a good medical degree, he resolved to go through a second special course of training in the University of Oxford, where he accordingly entered his name as a student, both in arts and medicine, on the books of Wadham College, from which he graduated B.A. and M.B. in 1843, and finally M.D. in 1859.

During the early years of his professional career, Dr. Jago was a most voluminous writer on various medical subjects, the most important of which are undoubtedly those connected with certain special diseases of the eye. One of his first contributions on this subject is on "Points in the physiology and diseases of the eye," published in 1845. In this paper he develops certain entoptical methods of exploring the eye by means of divergent beams of light, which, in his opinion, is a theory which preceded all like solutions of the problem. In 1854, he communicated a paper to the Royal Society on "Ocular Spectres and structures

as mutual exponents," which was followed by another on the same subject in 1856. In 1857, a paper "On the functions of the tympanum" was also read before the Royal Society. These three papers are published in the "Proceedings of the Royal Society." Among his other medical papers which are mostly inserted in medical journals and proceedings of kindred societies, the following will give a good example of the Author's investigations:—"The Eustachian Tube, why opened in deglution", 1856; "Entacoustics," 1868; "The Eustachian Tube, when and how it is opened," 1869; "Pains in the abdominal and thoracic walls," 1861; "Ophthalmoscopic muscæ volitantes in a very myopic eye," 1861; "Medicine as influenced by scientific tendencies," 1861; and "On Entoptics," 1859. So much interest was taken by physicians in Dr. Jago's paper on Entoptics, that he was encouraged to continue his investigations on this subject, which resulted in the publication of a separate treatise in 1864, entitled, "Entoptics, with its uses in physiology and medicine." While engaged on this important work, Dr. Jago exerted himself to produce a real treatise, in which, while giving his own views in some detail, he does not fail to make the reader acquainted with the views of other writers. The work is a masterly exposition of a difficult subject, especially as the Author has ventured on untrodden ground, while investigating and suggesting explanations of phenomena relating to the subject, which had not hitherto been sufficiently accounted for. Dr. Jago evidently brought many original thoughts to bear on this difficult question. These attracted the notice of some of the leading scientific members of the profession, as tending to physiological conclusions which would probably lead to a correct solution. Among those who were specially interested in Dr. Jago's investigations, was Dr. William Sharpey, F.R.S., then one of the Secretaries of the Royal Society, through whose influence principally, Dr. Jago was elected on June 2nd, 1870, a Fellow of the Royal Society. One of his proposers was Sir Charles Lemon, Bart., whose signature appeared first on the original certificate of candidature, which had been suspended in the rooms of the Society a few years before his election.

Dr. Jago was also an occasional contributor to the "Reports" and "Journal of the Royal Institution of Cornwall." Of these

papers the titles of a few may be sufficient here :—"The opening of the Eustachian Tube, limited to the act of deglutition, now first rightly explained," 1853. This appears to be the original of a second paper on this subject alluded to above; "Observations of the Solar phenomena of April 5, 1871," 1872; "Nangitha Cross, with illustration," 1874; "Ancient Cross at Trelanvean, St. Keverne," 1881; and his Presidential Addresses delivered at the Annual Meetings of the Institution in 1873-1875.

Besides enjoying a large private practice, Dr. Jago generously gave his services and experience to most of the local medical institutions. In 1852, he was elected Physician to the Truro Dispensary, and its consulting Physician in 1856; and Physician to the Royal Cornwall Infirmary in 1856, and consulting Physician in 1885. Filling so prominent a position as Dr. Jago did in the management of the Royal Institution of Cornwall, it was only natural that he should be called upon to undertake the active duty of one of the Honorary Secretaries, and in due time afterwards that of President. To the latter important office, which has usually been held by a distinguished Cornishman, he was elected on November 18, 1873, for two years. His Presidential Addresses delivered to the members at the annual meetings, have all been marked by their devoted interest in notifying the general progress of the Institution, and even at the present time the information contained in them may be read with profit. As a Vice-President, Dr. Jago continued, as long as he was able, to take his personal share of work, and his presence at the annual meetings was always looked upon as certain. Lately, however, owing to his feeble health, he was compelled to forego what to him was a great deprivation, but though absent from the meetings his interest in the proceedings never abated. It has been stated that our Institution was the only one in the city in which he, after his retirement from practice in 1885, retained an intimate interest. This was very evident to anyone who had had the pleasure of conversing with him during the later years of his life. In connection with this it is pleasing to note that though he was physically unable to attend the annual meetings, he made it a point, if possible, to

leave his card while on his accustomed afternoon drive. Even at the last annual meeting in November, 1892, he sent a note to the Chairman apologising for his absence.

Dr. Jago was married on November 24, 1864, to Maria Jones, daughter of Mr. Richard Pearce, several times Mayor of Penzance, by whom he leaves two daughters. He enjoyed generally good health until 1885, when he was slightly attacked with paralysis. From that year his weakness yearly increased, though his intellect remained as clear as ever. If possible, he always endeavoured to have his afternoon airing in an open carriage, accompanied by Mrs. Jago, or his daughters. Even on the Friday preceding his death, he went for his usual drive, but he had been ailing rather more than usual during the week. On Saturday he had a fresh though slight seizure, but he apparently soon again rallied. On Tuesday he became unconscious. On Wednesday, January 18, 1893, at 4.35 p.m. he passed away peacefully, aged seventy-seven. On the Saturday following his remains were laid to rest in the churchyard at Kenwyn.

EDWIN DUNKIN, F.R.S.

(2)

Royal Institution of Cornwall.

LABEL LIST

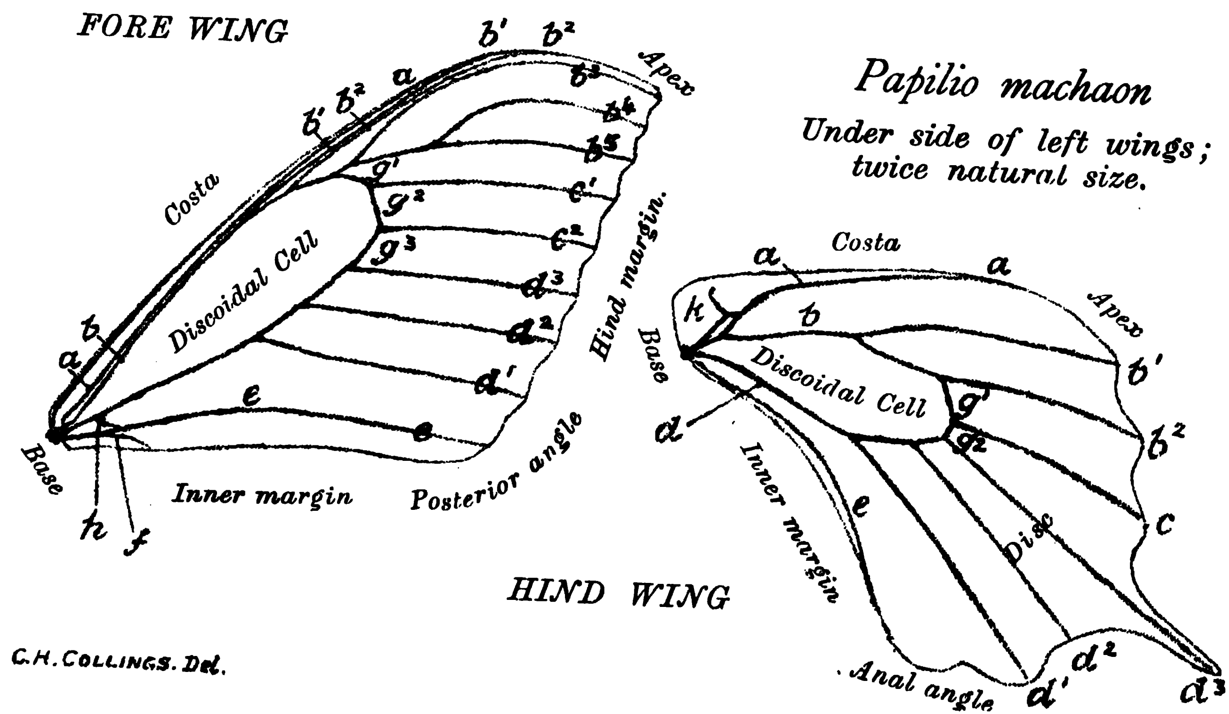
OF

BRITISH LEPIDOPTERA

BY

HENRY CROWTHER, F.R.M.S.,

CURATOR OF THE TRURO MUSEUM.



Papilio machaon

Under side of left wings; twice natural size.

REFERENCE LIST OF LETTERS IN PLATE.

a. Costal nervure.

b. Sub-costal nervure.

b^1, b^2, b^3, b^4, b^5. Sub-costal nervules.

c^1, c^2. Discoidal nervules.

d. Median nervure.

d^1, d^2, d^3. Median nervules.

e. Sub-median nervure.

f. Internal nervure.

g^1, g^2, g^3. Disco-cellular nervules.

h. Interno-median nervule.

k. Precostal nervure.

The letters correspond in each figure.

INTRODUCTION.

A few remarks are perhaps necessary, on some of the names appearing in this list, which have probably no greater right in it, than many, which, although appearing in the lists of Doubleday and others, have been omitted here.

The names of some butterflies have been expunged from certain British lists because the types are said to be extinct, or the records of their occurrence extremely doubtful, yet these recording lepidopterists so disagree, that no two retain the same specific names throughout their descriptions, in consequence an unqualified list of British Lepidoptera cannot be drawn up. Under such circumstances it is better to retain the names of some doubtful species, rather than circumscribe the usefulness of the list by deleting every capture, which has not been re-verified.

From some attention I have given to the distribution of shore insects, I have charity sufficient to believe, in the possibility of occasional European forms being found on the east and south coasts of Britain. One swallow does not make a summer, neither does an occasional captured butterfly make a new British insect, but as the records of such captures are highly prized by those who study animal distribution, they ought to be encouraged. We allow the ornithologist to interleave his Yarrell with doubtful records without demur, but somehow, the humbler lepidopterist gets but scant justice, if he proclaims the discovery of a widely distributed European form in Britain.

I have followed in the arrangement, Mr. W. F. Kirby's "European Butterflies and Moths," as the book is easily accessible, or already in the hands of many collectors, and contains descriptions of types near akin to our own, which the student probably buys in many cases as British. I see no harm in having a collection in which doubtful or extinct British species are replaced by Continental ones, if the replacement leads the student to wider reading and comparison.

The plate illustrating the characters of the wings has been drawn for me by my friend Mr. C. H. Collinge, of London, from the Swallow-tail butterfly, *Papilio Machaon*, L., which is the only English butterfly that posesses typical neuration. The drawing is twice the size of the original, so that the costal nervures and sub-costal nervules may be easier made out; and of the under side of the wing, because on the upper aspect the precostal nervure (*k*) on the hind wing in not visible; and for identification, the under side is clearer. As every character has been verified under the microscope, I feel this addition to the label list will be valued by the student.

I have to thank Mr. Charles G. Clark, F.E.S., of London, and Mr. S. L. Mosley, F.E.S., of Huddersfield, for their general criticisms on the doubtful types. From these, and personal and other observations the few remarks below on the distribution, have been drawn up; they are of necessity very brief, but I think essential to the list.

Papilio Podalirius, L. Not British, no certainty it ever was. Continental form.

Parnassius Apollo, L. Probably introduced, no specimens taken in Great Britain. Alps and Pyrenees.

Pieris Napi, var. *Sabellicæ*, Steph. A variety with black nervures, and rare. Var. *Napeæ*, Steph., a slightly larger form, no characteristic value.

Pieris Rapæ, L. Commonest English butterfly. Vars. *Metra*, Steph. and *Mera*, Steph. as variety names are worthless. Var. *Novangliæ*, Scudd., kindly shewn me at the Natural History Museum, South Kensington, by Mr. A. G. Butler, F.L.S., is the yellow variety, which, though somewhat rare in Europe, is very common in America.

P. Brassicæ, var. *Chariclea*, Steph. Is a small form, not separable from type.

Aporia Cratægi, L. Now believed to be extinct.

Colias Hyale, L. In some years very rare.

C. Edusa, Fabr. Common in 1877, rare since. Var. *Helice*, Hübn. is a white form of the female.

Vanessa Antiopa, L. Periodically common; 1878 is the *Antiopa* year of lepidopterists.

V. Cardui, L. Periodically common. Var. *Elymi*, Robson, not British.

Melitæa Aurinia, Rott. Local, and becoming rare owing to habitats being destroyed by drainage.

M. Athalia, Esp. Locally abundant, confined to south of England and Ireland.

Argynnis Aglaia, L. Becoming rather rare.

A. Lathonia, L. Very rare and uncertain.

A. Paphia, var. *Valesina*, Esp. Dark variety of female, now almost confined to New Forest, Hampshire.

A. Niobe, L. By some lepidopterists thought to be a form of *Adippe*, probably not British, the Kentish captures were false, and those of the New Forest are doubtful.

A. Dia, L. Not known as British, except on two doubtful records.

Erebia Ligea, L. No authenticated British specimens exist.

Melanargia Galanthea, L. The variations of forms so common, from suffusion of black, is melanism only.

Satyrus Ægeria, L. The form found in the south of Europe.

Epinephile Janira, L. The second commonest British butterfly.

Polyommatus Semiargus, Rott. Local and almost extinct in England.

P. Minima, Fuessly. The smallest English butterfly.

P. Bœticus, L. One or two specimens have been collected, it is said, on the south coast, but no real claim to be considered British.

Lycæna Dispar, Haw. Extinct in Britain, since 1848; was a true British insect; the Continental form is *L. Rutilus*, Werneb., the Dark Under-winged Copper.

L. Virgaureæ, L. Said to have existed in the Fens, but no locality known, nor any authenticated specimens. A specimen, it is said, was taken at Cromer a year or two ago.

Thecla Pruni, L. Local insect, probably confined to about five counties, Huntingdonshire, Suffolk, Hampshire, Monmouthshire, and Derbyshire.

Pamphila Lineola, Ochs. Eastern counties of England, local, until recently overlooked.

The extensions, of the abbreviated names of the authorities used in the list, are given on page xviii. On the same page will be found the signs which the student may need to distinguish the male (♂) and female (♀) forms.

The rules between the lines are scissor guides for cutting up the list.

This label list was drawn up for use in the Museum of the Royal Institution of Cornwall, and by request extra copies were struck off for the use of students.

CLASS INSECTA--HEXAPODA.

ORDER Lepidoptera [*Scale-winged Insects*];

BUTTERFLIES & MOTHS.

Insects with suctorial mouth-parts, which form a spirally rolled proboscis, with four similar wings which are completely covered with scales. The prothorax is fused. Metamorphosis complete, *i.e.* these insects pass through three stages after leaving egg; (1) caterpillar or larva; (2) chrysalis or pupa; (3) perfect butterfly or moth. They grow in stage 1 only, not in stages 2 and 3.

TRIBE RHOPALOCERA [*Club-horns or Butterflies*].

Lepidoptera of slender build, usually with brightly coloured wings and clubbed or knobbed antennæ. All European butterflies fly in daylight, usually hold their wings upright and applied together when at rest. Caterpillars which may be naked or clothed with hairs or spines have sixteen feet, six of which are horny, the rest (claspers) fleshy. For the most part the caterpillars develop without cocoons into pupæ or chrysalides occasionally of a metallic lustre, which attach themselves to leaves, twigs, stones, &c.

[*The Habitat and Time of Appearance of each species are given after the specific name*].

FAMILY 1. PAPILIONIDÆ.

Both sexes with six perfect legs; inner margin of the hind wings concave; larvæ long, cylindrical, not spiny; pupæ attached by the tail, and a belt of silk round the body.

Genus 1. Papilio, *L.*

P. Podalirius, *L.* Scarce Swallow-tail.
Open places near Woods,—June and July.

P. Machaon, *L.* Swallow-tail.
Cambridge and Norfolk Fens,—May to July.

Genus 2. Parnassius, *Latr.*

P. Apollo, *L.* Crimson Ringed.
Mountains,—June and July.

FAMILY 2. PIERIDÆ.

Characters in common with Papilionidæ, but the inner margin of the hind wings is not concave.

Genus 1. Leucophasia, *Steph.*

L. Sinapis, *L.* Wood White.
Woods,—May and August.

L. Sinapis, var. Erysimi, *Borkh.*

L. Sinapis, var. Diniensis, *Bdv.*

Genus 2. Euchloe, *Hübn.*

[Anthocharis of some Authors].

E. Cardamines, *L.* Orange Tip.

Fields and Lanes,—May.

Genus 3. Pieris, *Schrk.*

P. Daplidice, *L.* Bath White.

South coast,—August.

P. Napi, *L.* Green-veined White.

Fields and Lanes,—May and August.

P. Napi, var. Sabellicæ, *Steph.*

P. Napi, var. Napeæ, *Steph.*

P. Rapæ, *L.* Small Cabbage White.

Gardens,—May and August.

P. Rapæ, var. Metra, *Steph.*

P. Rapæ, var. Mera, *Steph.*

P. Rapæ, var. Novangliæ, *Scudd.*

P. Brassicæ, *L.* Large Cabbage White.

Gardens,—May and August.

P. Brassicæ, var. Chariclea, *Steph.*

Genus 4. Aporia, *Hübn.*

A. Cratægi, *L.* Black-veined White.
Meadows, South of England,—June and July.

Genus 5. Colias, *Fabr.*

C. Hyale, *L.* Pale Clouded Yellow.
Lucerne fields,—July.

C. Hyale, var. Pallida, ***Robson.***

C. Edusa, ***Fabr.*** Clouded Yellow.
Clover fields, South of England,—Aug.—Nov.

C. Edusa, var. Helice, ***Hübn.***

Genus 6. Gonepteryx, *Leach.*

G. Rhamni, *L.* Brimstone.
Lanes and Woods,—July and August.

FAMILY 3. NYMPHALIDÆ.

Moderately large brightly coloured butterflies. Fore-legs of male (♂) quite rudimentary (apparently two jointed), female (♀) separate portions are present, but small. Larvæ spiny, or with fleshy warts covered with hair, or horns on the head. Pupæ suspended by the tail.

Genus 1. Vanessa, *Fabr.*

V. Atalanta, *L.* Red Admiral.
Waste places,—August to October.

V. Antiopa, *L.* Camberwell Beauty.

Willow beds,—Spring and Autumn.

V. Antiopa, var. Hygiæa, *Hdrch.*

V. Io, *L.* Peacock.

Waste places,—August to October.

V. Urticæ, *L.* Small Tortoiseshell.

Waste places,—April to October.

V. Polychloros, *L.* Large Tortoiseshell.

Open Woods,—Summer.

V. C-album, *L.* Comma.

Hop gardens,—Summer and Autumn.

V. C-Album, var. Hutchinsoni, *Robson.*

V. Cardui, *L.* Painted Lady.

Waste places,—August to June.

V. Cardui, var. Elymi, *Robson.*

Genus 2. Melitæa, *Fabr.*

These Fritillaries are not spotted nor streaked with silver. Larvæ feed on plantain, &c.

M. Aurinia, *Rott.* Greasy Fritillary.

M. Artemis, *Steph.*

Marshy Meadows,—May.

M. Aurinia, var. Hibernica, *Birch.*

M. Aurinia, var. Scotia, *White.*

M. Cinxia, *L.* Glanville Fritillary.
Sea Cliffs, Isle of Wight,—May and June.

M. Athalia, *Esp.* Heath Fritillary.
Heaths,—Midsummer.

M. Athalia, var. Eos, *Steph.*

Genus 3. Argynnis, *Fabr.*

The under-side of the hind wings of these Fritillaries is always spotted or streaked with silvery white. Larvæ feed chiefly on violets.

A. Selene, *Schiff.* Small Pearl-bordered Fritillary.
Woods,—June.

A. Euphrosyne, *L.* Pearl-bordered Fritillary.
Woods,—May and June.

A. Adippe, *L.* High-brown Fritillary.
Woods,—July.

A. Adippe var. Cleodoxa, *Ochs.*

A. Aglaia, *L.* Dark-green Fritillary.
Downs and Wastes near Sea, Mountain Heaths,—July.

A. Aglaia, var. Charlotta, *Sowby*.

A. Lathonia, *L*. Queen of Spain Fritillary.
South coast,—September.

A. Paphia, *L*. Silver-washed Fritillary.
Woods,—July.

A. Paphia, var. Valesina, *Esp*.

A. Niobe, *L*. Niobe.
New Forest,—June and July.

A. Dia, *L*. Weaver's Fritillary.
Woods,—Spring and Autumn.

Genus 4. Limenitis, *Fabr*.

L. Sibylla, *L*. White Admiral.
Woods, South of England,—July.

Genus 5. Apatura, *Fabr*.

A. Iris, *L*. Purple Emperor.
Oak woods,—July.

A. Iris, var. Iole, *Schiff*.

FAMILY 4. SATYRIDÆ.

Large or small, dull coloured, butterflies. Front pair of legs rudimentary. Wings rounded, hind margins either entire or scalloped, and nearly always with ocellated spots. Larvæ clothed with fine, short hair, tail ends in a fork, head is round. Pupæ suspended by tail, or formed in, or on, the ground.

Genus 1. Hipparchia, *Fabr.*

[Satyrus of some Authors].

H. **Semele,** *L.* Grayling.

Rocky and Sandy places,—July and August.

Genus 2. Erebia, *Bdv.*

E. **Epiphron,** *Knoch.* Small Ringlet.

Mountains in the North,—June and July.

E. **Epiphron, var. Cassiope,** *Fabr.*

E. **Æthiops,** *Esp.* Scotch Argus.

E. Medea, *Hübn*; E. Blandina, *Fabr.*

Mountain Flats,—July and August.

E. **Ligea,** *L.* Arran Brown.

Mountain Districts,—June and July.

Genus 3. Melanargia, *Meig.*

[Arge of some Authors].

M. **Galathea,** *L.* Marbled White.

Open Woods,—July.

Genus 4. Satyrus, *Latr.*

[Pararge of some Authors].

S. Megæra, *L.* Wall Brown.
Lanes,—May and August.

S. Ægeria, *L.* Speckled Wood.
Woods,—May.

S. Ægeria, var. Egerides, *Staud.*

Genus 5. Epinephile, *Hübn.*

[Satyrus of some Authors].

E. Hyperanthus, *L.* Ringlet.
Woods and Lanes,—July.

E. Hyperanthus, var. Arete, *Müll.*

E. Janira, *L.* Meadow Brown.
Pastures,—Summer.

E. Janira, var. Hispulla, *Esp.*

E. Tithonus, *L.* Large Heath.
Lanes,—July.

Genus 6. Cœnonympha, *Hübn.*

[Satyrus and Chortobius of some Authors].

C. Pamphilus, *L.* Small Heath.

Dry Heaths,—May to October.

C. Pamphilus, var. Lyllus, *Esp.*

C. Typhon, *Haw.* Marsh Ringlet.

C. Davus, *Fabr.*

Damp Heaths,—June and July.

C. Typhon, var. Rothliebi, *Staud.*

FAMILY 5. ERYCINIDÆ.

Only one species in Europe, moderately large, and brown in color. Male (♂) front legs rudimentary; female (♀) legs perfect. Palpi of moderate length. Antennæ long. Hind wings slightly grooved, sub-costal nervure with four branches. Larvæ wood-louse shape. Pupæ attached by tail, and girth around body.

Genus 1. Nemeobius, *Steph.*

N. Lucina, *L.* Duke of Burgundy.

Damp Woods,—June.

FAMILY 6. LYCÆNIDÆ.

Small blue, copper-red, and brown butterflies. Club of antennæ rather long. Palpi hairy, last joint naked. Front legs perfect in female (♀). Larvæ wood-louse shape, clothed with fine short hairs, head small and retractile. Pupæ attached like *Erycinidæ.*

Genus 1. Polyommatus, *Latr.*

[Lycæna of some Authors].

In *Polyommati* or Blues the antennæ are slender. Upper side of wings of male (♂) blue, seldom brown; of female (♀) brown, dusted with blue. Palpi long. Eyes sometimes hairy, sometimes naked. Larvæ feed on leguminous plants.

P. Arion, *L.* Large Blue.

Cotswolds, &c.,—June and July.

P. Semiargus, *Rott.* Mazarine Blue.

P. Acis, *Fabr.*

South Wales,—June and July.

P. Minima, *Fuessly.* Bedford Blue.

P. Alsus, *W.V.*

Waste places,—June.

P. Argiolus, *L.* Azure Blue.

Holly hedges,—May and August.

P. Corydon, *Poda.* Chalk-hill Blue.

Chalk Downs,—May to July.

P. Bellargus, *Rott.* Clifden Blue.

P. Adonis, *Hübn.*

Chalk Downs,—May.

P. Icarus, *Rott.* Common Blue.

P. Alexis, *W. V.*

Waste places,—Summer.

P. Icarus, var. Icarinus, *Scriba.*

P. Icarus, var. Thersitis, *Bdv.*

P. Astrarche, *Bergstr.* Brown Argus.

P. Medon, *Esp.* P. Agestis, *Hübn.*

Waste places,—May and August.

P. Astrarche, var. Artaxerxes, *Fabr.*

P. Astrarche, var. Salmacis, *Steph.*

P. Astrarche, var. Allous, *Hübn.*

P. Ægon, *W. V.* Silver-studded Blue.

Heathy places,—July.

P. Bœticus, *L.* Pea-pod Argus.

Channel Islands,—September and October.

Genus 2. Lycæna, *Fabr.*

[Chrysophanus & Polyommatus of some Authors].

In the *Lycænæ*, or Coppers, the antennæ are long. Upper side of wings of male (♂) copper red; of female (♀) copper to brown. Palpi long. Eyes naked. Larvæ feed on dock and sorrel.

L. Chryseis, *Ochs.* Purple-edged Copper.
L. Eurydice, *Rott.* L. Hippothoe, *L.*

L. Dispar, *Haw.* Large Copper.
Fens, Cambridge,—June to August.

L. Virgaureæ, *L.* Scarce Copper.
No known locality.

L. Phlæas, *L.* Common Copper.
Waste places,—April to September.

Genus 3. Zephyrus, *Dalm.*

[Thecla of some Authors].

Differ from *Theclæ* in the gradually formed club. In fore-wings having eleven nervures, sub-costal nervure emitting two branches before the extremity of the discoidal cell, and a third beyond, which is bifurcated.

Z. Betulæ, *L.* Brown Hairstreak.
Blackthorn Woods,—July to October.

Z. Quercus, *L.* Purple Hairstreak.
Oak Woods,—July to August.

Genus 4. Thecla, *Fabr.*

Differ from *Zephyri* in suddenly formed club on antennæ. In fore-wings having ten nervures; sub-costal nervure emitting three unforked branches before extremity of discoidal cell, and none afterwards.

T. Rubi, *L.* Green Hairstreak.

About Brambles,—May and June.

T. Pruni, *L.* Dark Hairstreak.

Monk's Wood,—June and July.

T. W-album, *Knoch.* White Letter Hairstreak.

Elm Woods,—July.

FAMILY 7. HESPERIIDÆ.

Small thick-bodied butterflies, with short wings and jerky flight. Antennæ inserted widely apart and often hooked at the tips. Legs perfect in both sexes; hind tibiæ with four spurs. Larvæ with prominent head, body tapering at both ends and clothed with fine thin hair, live usually between leaves spun together, and undergo changes there in a slight cocoon.

Genus 1. Hesperia, *Fabr.*

[Syrichthus of some Authors].

H. Malvæ, *L.* Grizzled Skipper.

H. Alveolus, *Hübn.*

Damp Woods,—May.

H. Malvæ, var. Taras, *Bergstr.*

Genus 2. Nisoniades, *Hübn.*

[Thanaos of some Authors].

N. Tages, *L.* Dingy Skipper.

Waste places,—May.

Genus 3. Cyclopides, *Hübn.*

[Steropes & Hesperia of some Authors].

C. Palæmon, *Pall.* Chequered Skipper.

C. Paniscus, *Fabr.*

Grassy openings in Woods,—May and June.

Genus 4. Pamphila, *Fabr.*

[Hesperia of some Authors].

P. Comma, *L.* Silver-spotted Skipper.

Rough fields, South of England,—July—August.

P. Sylvanus, *Esp* Large Skipper.

Open Woods,—May and August.

P. Actæon, *Esp.* Lulworth Skipper.

Dorset coast,—July and August.

P. Thaumas, *Hufn.* Small Skipper.

P. Linea, *W.V.*

Waste places,—July.

P. Lineola, *Ochs.* Narrow-lined Skipper.

Meadows and Cornfields,—July and August.

Extension of Abbreviated Names of Authorities.

Bdv. (Boisduval).
Bergstr. (Bergstraesser).
Birch.
Borkh. (Borkhausen).
Dalm. (Dalman).
Esp. (Esper).
Fabr. (Fabricius).
Fuessly.
Haw. (Haworth).
Hdrch. (Heydenreich).
Hübn. (Hübner).
Hufn. (Hufnagel).
Knoch.
L. (Linné).
Latr. (Latreille).
Leach.
Meig. (Meigen).
Müll. (Müller).
Ochs. (Ochsenheimer).
Pall. (Pallas).
Poda.
Robson.
Rott. (Rottenburg).
Schiff.
Schrk. (Schranck).
Scriba.
Scudd. (Scudder).
Sowby. (Sowerby).
Staud. (Staudinger).
Steph. (Stephens).
W. V. (Wiener Verzeichniss).
White.

Characters to Distinguish Male and Female Forms.

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